APRIL 17, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

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APR 17 1961
TECHNOLOGY DEPARTMENT

V.8 #16

Was Russian Manned Spacecraft Military Prototype?

- Can U.S. Cut The M-I-S Gap?
- Biochemical Fuel Cell Here
- MHD Results Beat Forecasts

First Man in Space— Russia's Yuri Gagarin

AN AMERICAN AVIATION PUBLICATION

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LIBRASCOPE COMPUTER FACILITIES

Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and production facilities. For your computer requirements, call on the company whose breadth of diversification in computer technology is unsurpassed. ■ Librascope Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif. For career opportunities write to John Schmidt, Engineering Employment. ■

computers that pace man's expanding mind

GP

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Microdot Expands Telemetry Capability

South Pasadena — Microdot Inc. has recently acquired Spectralab Instrument Co. of Monrovia, California. The acquisition provides Microdot's Instrumentation Division with outstanding capabilities in the field of VHF and UHF cavities and related instrumentation. Spectralab has been widely noted for its recent scientific breakthrough in the new UHF telemetry field with the first operational UHF telemetry transmitter, and for its high power transmitter designed for the Pioneer V satellite. Spectralab instruments have also flown in the Redstone, Jupiter, Atlas and Pershing missiles.

The Pioneer V transmitter shown above is typical of the sophisticated instrumentation now offered by Microdot. This miniaturized unit features an output of 150 watts, ease of adjustment, and proven outer space reliability.

With the Spectralab acquisition, Microdot's telemetry capability now includes a broad product line ranging from sensing devices through transmitters. As a single source for instrumentation, Microdot can provide weldable strain gages, load cells, temperature probes, thermocouples, amplifiers, power supplies, signal conditioning equipment, power amplifiers, frequency doublers, oscillators and transmitters.

MICRODOT INC.

220 Pasadena Avenue
South Pasadena, California

Circle No. 2 on Subscriber Service Card

"MAKE A NOISE IN THE EAST, BUT STRIKE IN THE WEST"

Mao-Tse-Tung's arsenal is impressive: 700-million expendable people. And soon, nuclear capability.

To those of us in the defense business the prospect is worthy of sober consideration. We cannot match Red China in expendable human lives. Instead we must rely upon the effectiveness of our defense capabilities to keep fingers off buttons.

The responsibility is clear. The real business of the defense business is survival.

Electronics at Boeing

Electronics, symbolized by this diagrammatic representation, is a rapidly expanding field of activity at Boeing. Here engineers and scientists are at work in research, design and test areas of electronics. Activities cover a broad spectrum, from advancement of the state-of-the-art to the development, manufacture and installation of electronic systems.

Boeing scientists and engineers are also advancing the state-of-the-art in many other areas, including military jet aircraft, commercial jet transports, hypersonic flight, helicopters, vertical and short take-off and landing aircraft, gas turbine engines, space systems, antennas and hydrofoils. In addition, scientists of Boeing's Allied Research Associates subsidiary developed techniques and interpretive methods to analyze data transmitted to earth by Tiros I and Tiros II meteorological satellites.

Professional-Level Openings

Engineers and scientists—and professional specialists in business and management disciplines—will find career opportunities of unusual scope and potential at Boeing, as well as a stimulating environment conducive to rewarding achievement and rapid advancement. Drop a note now, mentioning degrees and major, to Mr. John C. Sanders, Boeing Airplane Company, P.O. Box 3822-MIL, Seattle 24, Washington.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 8, Number 16 April 17, 1961

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THE COVER

Soviet Air Force Maj. Yuri A. Gagarin, first man to break through the space barrier, orbit the earth and return safely. (UPI radiotelephoto). See report on p. 14.

APRIL 17 HEADLINES

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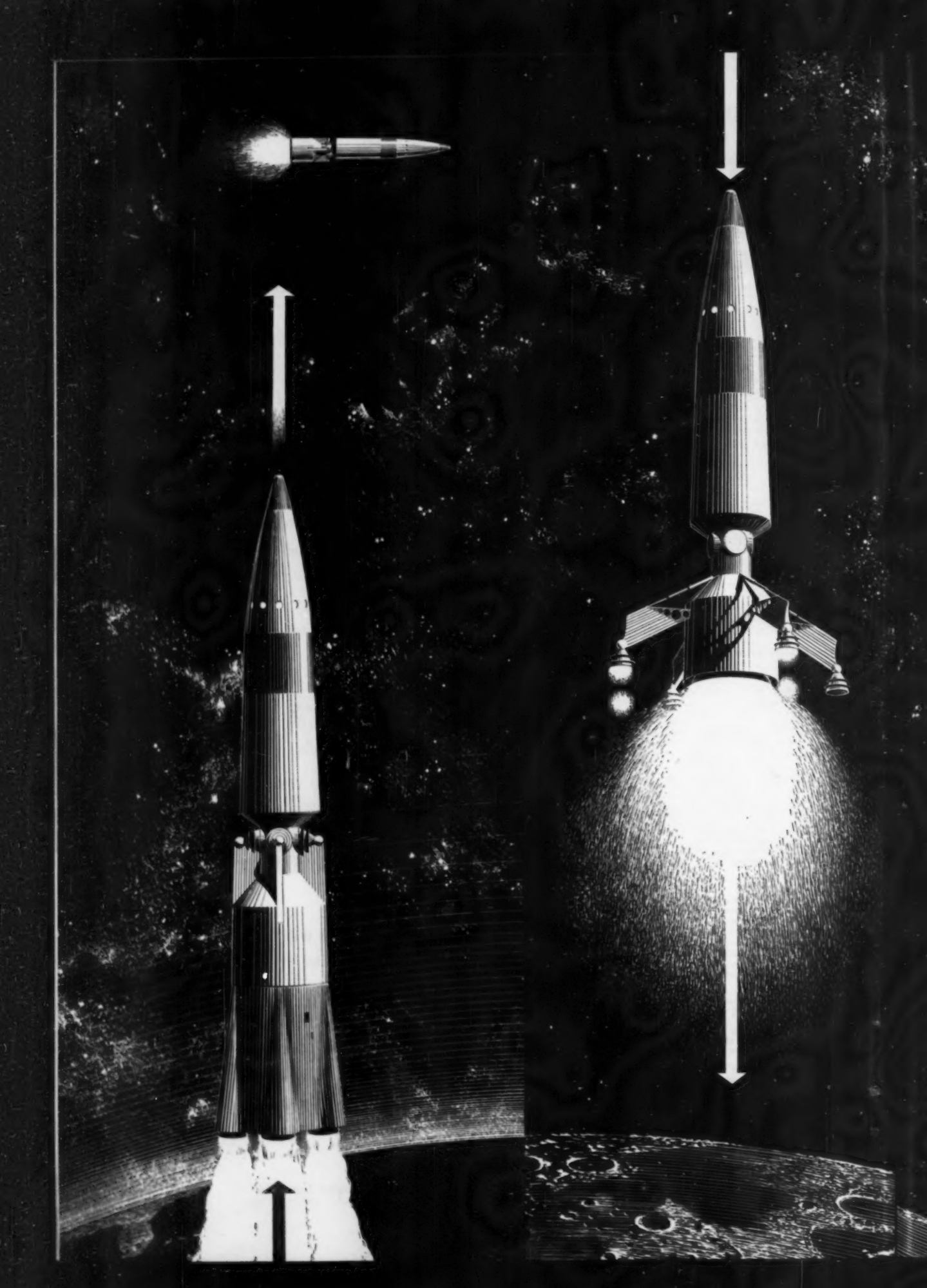


MARQUARDT ROCKET ENGINES SPAN THE POWER SPECTRUM

Recently developed throttleable engine capable of 250,000 pounds of thrust

A large rocket engine burning high-energy boron fuel and a storable oxidizer has demonstrated the highest performance ever attained with storable liquid propellants. In a static test firing the engine operated at 98% efficiency using a combustor design developed from high-energy fueled ramjets. The tests — part of a program sponsored by the Air Force — although limited to 100,000 pounds of thrust, proved an operational capability exceeding any ever attained with storable liquid propellants in large scale firings.

The concept of Energy Management[1] as applied to a variety of space systems requires rocket engines with throttling and restart capabilities. Marquardt liquid rocket engines share the following distinct advantages: throttleable rocket performance; ability to be restarted at altitude; near theoretical maximum performance; scaling by multiplicity; no regenerative cooling.

Marquardt has also achieved significant performance results in the development and testing of liquid rockets in the low and intermediate thrust range — from one pound to 15,000 pounds. These rockets are throttleable over a wide thrust range with no efficiency drop-off (see C* efficiency graph shown at right).

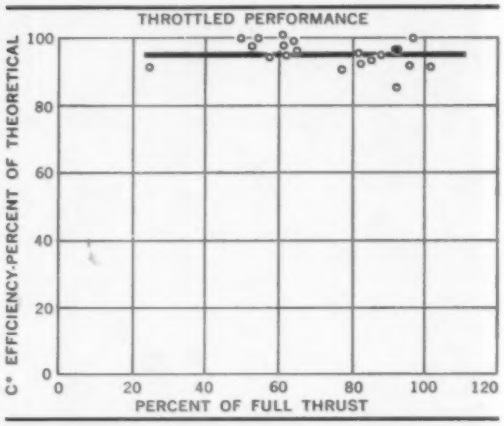
Radiation cooled rockets can be controlled accurately down to a few milliseconds in duration — as low as 0.003 pound-seconds impulse bits. A radiation cooled rocket motor has operated for over 23 minutes at a thrust efficiency of 90%. This design has demonstrated reliable ignition at 10^{-5} mm of mercury.

The development of rocket power plants of advanced design and near theoretical maximum performance is based upon sixteen years of experience and leadership in the propulsion field. Successful participation in and direction of more than 100 major high-altitude research rocket programs including the Explorer VIII and Vanguard satellite launching programs lend further support to Marquardt's leadership in the propulsion field. Capabilities in the research rocket area range from solid propellant rocket motor design and fabrication through final data reduction and information presentation.

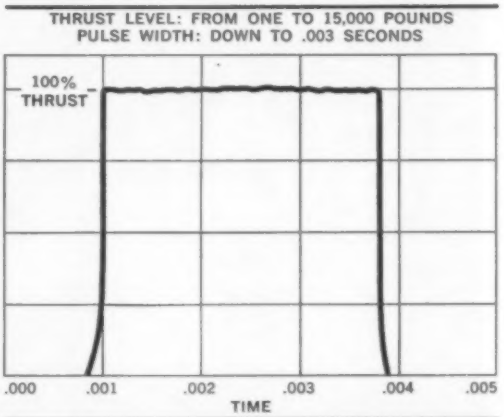
For information concerning Marquardt propulsion systems contact Don L. Walter, Vice President, Power Systems Group.

Scientists and engineers experienced in the fields of advanced propulsion devices are invited to investigate exceptional career opportunities with The Marquardt Corporation.

[1]*Energy Management — The technique of programming the use of stored chemical energy in a space system for maximum performance.*



VARIABLE THRUST ROCKET ENGINE
A typical group of rocket test firings using storable liquid propellants prove an average C* efficiency of 95% over a wide throttling range.



DOCUMENTED IMPULSE CAPABILITY
The above trace represents one impulse bit — demonstrating controllability of pulse width down to .003 seconds.

THE Marquardt CORPORATION

CORPORATE OFFICES, VAN NUYS, CALIFORNIA

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Insulation News from Johns-Manville

Min-K® soars through space —and back!

J-M INSULATION, WITH k LOWER THAN THE MOLECULAR CONDUCTION OF AIR, SHIELDS AGAINST EXTREMES OF HEAT AND COLD

As the Mercury Space Craft is launched, orbits and is recovered, exterior temperatures range from around —100F to plus 1600F. Yet, only inches away, inside the space vehicle, temperatures never fall below or exceed comfort and health levels. The reason? Two Johns-Manville insulations, selected by McDonnell Aircraft Corporation and the NASA, are doing their job to perfection. They are the *only* thermal insulations used in the space craft.

One of these is Min-K, the super insulation for critical areas. This unique material exhibits a marked reduction of thermal conductivity as atmospheric pressure decreases. Min-K also possesses a thermal diffusivity lower than ordinary materials which weigh five times as much. Thus, it is possible to control thermal transients at a fraction of such weights.

For other sections of the Space Craft, where controlled heat flow was necessary, J-M Thermoflex RF Felt was used. Together, the Johns-Manville insulations make up a team that helps solve the space travel problem.

Solving insulation problems is a Johns-Manville specialty. For assistance on *your* problems, details on Min-K and other J-M aviation insulations, write J. B. Jobe, Vice-President, Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

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letters

Close More Doors

To the Editor:

I have just read your editorial, "An Open Purse and a Shut Mouth" (M/R, March 20, p. 50).

I heartily endorse your stand and opinions.

More doors at technical meetings should be closed to the Russians. We are foolish to give them all the information and knowledge we have developed. I am quite sure they don't give us all or any secrets or skills.

B. John Skawinski
Waterford, Conn.

Sub Simulator Batteries

To the Editor:

In view of the increasing importance of developments in the field of antisubmarine warfare, you and Mr. Beller are to be congratulated on your fine article, "Navy Getting Sub Target Simulators" (M/R, March 3, p. 28).

We feel very strongly, however, that the type of battery used—whether lead-acid, nickel-cadmium, silver-zinc or silver-cadmium—is of great interest to engineers.

For the record, then—and for the information of those in the field who have called us to ask—the primary source of power for these new target simulators is a rechargeable *silver-zinc* battery manufactured by Yardney Electric Corporation.

Saul Padwo
Assistant to the Vice President
Yardney Electric Corp.
New York, N.Y.

Optical Alignment

To the Editor:

Reference your article on the Twist Autocollimator optical alignment system for the *Minuteman* (M/R, Feb. 6, p. 33), as well as the letter of C. J. Weatherred (M/R, March 20, p. 48).

Your report on the system was superb, and Mr. Weatherred's letter was well justified. He was absolutely right in stating that Dr. J. G. Gievers is the Free World father of phased light systems for optical alignment. It is interesting to point out that such a system was available to the Army as early as 1957, but was ignored by some workers of the Von Braun team who didn't have the technical background to understand the system well enough to push its application for the *Redstone* and *Jupiter* missile systems. Fortunately, with excellent wisdom, most of these individuals are no longer with the team now employed by the Marshall Agency of NASA.

An additional point is worthy of mention—the Army, at that time, had little interest in even passive optical alignment devices for its *Redstone* and *Jupiter* systems—those states of the art which had been most effectively applied at Peenemünde when flatcar-stationed *V-2's* were fired with effectiveness, and when the German artillery hit targets with telling accuracy.

One sometimes wonders—maybe ex-Secretary of Defense Wilson *was* right in restricting the range of Army missiles.

Frank M. Cameron
Huntsville, Ala.

No Slight Intended

To the Editor:

Enclosed you will find a letter from Mr. George Raymond of the Raymond Engineering Laboratory concerning an article ("New Breed of Recorders for Future Space Use") in M/R, Feb. 13. In the light of your recent editorial expressing concern about the deletion of contractors' names by certain Government agencies, I cannot help but feel that your treatment of the contributions of the NASA Research and Development activities is somewhat inconsistent.

At best, the issue is always a difficult one. I would hope that you could correct impressions left by your article on tape recorders in the referenced issue.

W. G. Stroud
Head, Meteorology Branch
Goddard Space Flight Center
NASA

Mr. Raymond's letter to NASA said in part:

"You have undoubtedly read the article about our tape recorders in M/R. Unfortunately there were some distortions in the article for which I wish to apologize on behalf of the company.

"We regret that the impression was left that we had designed and built the *Tiros II* satellite IR recorder. We acknowledge that our role here was minor, and that you people provided the technical leadership and skill which brought about the eventual success of the program. At the time the article was composed, the *Tiros II* satellite had not been launched, and our general association with the *Tiros II* recorder created the erroneous impression that the recorder was our own development and it would be in the satellite.

"The impressions left regarding the Mylar belts were also unfortunate. The only intent here was to state that we were using belts, and for what reasons, and not to claim their invention or development. We acknowledge, of course, that you and John were fully responsible for all of the basic work in this area. We are, in fact, grateful for the recent technical information published by you which has helped us in designing and fabricating belts for our own recorder developments. . . ."

Background information for the article was provided to M/R by Raymond Engineering Laboratory, Inc., with the stipulation that the final version of the story be reviewed for technical accuracy by NASA. The story was reviewed at the Goddard Space Flight Center and approved Feb. 8, 1961, subject to one correction—the weight of the S-15 satellite was increased from 350 to 425 lbs. No other corrections were indicated.—Ed.

System Development • Communications • Data Link • Countermeasures Actuators • Missile, Weapon and Space Vehicle Research • Infra-Red and Microwave R & D.

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RESEARCH DIVISION
Timonium (Baltimore), Maryland

ADVANCED TECHNOLOGY CORPORATION (ADTEC)
Santa Barbara, California

Circle No. 26 on Subscriber Service Card

INERTIAL ENGINEERING INGENUITY

The Litton LN-3 Inertial Navigation System is a system in being. Production orders for this system to be used in the F-104 are, to the best of our knowledge, larger in number than those for any other inertial guidance system. The LN-3, consisting of a two-gyro, four-gimbal platform, computer, adapter, and controls, weighs less than 80 pounds installed. Even smaller systems, designed for orbital and sub-orbital guidance, are in development. These will weigh less than half as much as systems now in production.

Do you have experience applicable to the integration of developmental inertial guidance and computer sub-systems into functioning prototype systems? Can you evaluate performance in such systems with a view toward increasing system capabilities even further? If so, contact Mr. Donald A. Krause of our Research and Engineering Staff regarding your interests. You can share in generous employee benefits, including stock purchase and tuition-paid education plans. Relocation assistance is provided.

LITTON SYSTEMS, INC.
GUIDANCE & CONTROL SYSTEMS DIVISION
Beverly Hills, California

A servo amplifier plug-in module in the LN-3 Computer is discussed by Harold F. Erdley, left, Director of Engineering, and Nathan P. White, LN-3 Program Manager.

The Countdown

WASHINGTON

The U.S. Space Program: More?

Many key congressional figures are now taking a second look at President Kennedy's FY '62 budget revisions in light of Russia's man-in-space feat. Their inescapable conclusion is that Kennedy made a clear decision NOT to try very hard to leapfrog the Soviets in space. Insiders are expecting a head-on struggle between Kennedy and congressional leaders who will demand an immediate step-up in space spending. Much depends, however, on public reaction. If there is no outcry, there may not be much of a fight.

Missile Money Request

Defense authorization bill now before the House holds $3.976 billion for missiles. Air Force portion is $2.792 billion, Army $550 million and the balance for the Navy.

Fight for Man-in-Air

Look for a possible switch in Air Force strategy before Congress. Big campaign now underway to restore funds to the B-70 may be dropped suddenly and the pressure redirected toward revival of the missile-carrying nuclear airplane. The Air Force is determined to get either one or the other.

Satellite Killer

All Navy work in the "area" of antisatellite missile development is now being done under a program labelled "Early Spring." Naval astronautics experts contend that they could demonstrate workability of their proposed system by shooting down a U.S. satellite within 18 months, using a ship as a launch platform.

More Advanced Terrier Development

COUNTDOWN hears there will be *Advanced Terrier* antiaircraft missiles aboard the aircraft carriers Constellation and Enterprise when they are commissioned this fall. Constellation, a Forrestal Class flattop, and the nuclear-powered Enterprise will each have two launchers for *Terriers*.

Falcon Production Ending

Air Force plans to buy out *Falcon* GAR 3A, 4A and 11 air-to-air missiles in the FY '62 budget, ending one of longest missile production runs.

Rubel Leaving?

Although he has been asked to stay on indefinitely, Dr. John H. Rubel is thinking of quitting as deputy director of DOD's Office of Defense Research and Engineering. The office is now headed by Dr. Harold Brown, a 33-year-old nuclear physicist who is expected to reverse some of the policies of his predecessor, Dr. Herbert York. Brown is concerned over using R&D to "better" long-range military strategy and dispense with "gimmicks."

INDUSTRY

Big Saturn S-II Stage Contract

NASA is getting ready to contract the largest rocket ever built by private industry—the 800,000-lb.-thrust *Saturn S-II* stage. It will measure 74 ft. in length, 21.5 ft. in diameter, and be powered by a cluster of four J-2 engines. Twenty firms are being invited to a pre-proposal conference April 18. List will be narrowed considerably before NASA invites bids. The contract probably will run to $100 million or more.

Maxson is Bullpup Prime

Contrary to Navy-released statements, Maxson Electronics is the second-source prime contractor for *Bullpup*, responsible for all components except GFE motor and shipping container. Approximately 60% of the work will be subcontracted—none from Martin-Orlando *Bullpup* suppliers—and Maxson will manufacture and assemble at its Old Forge, Pa., plant. Maxson beat out 50 competitors for the $1-million contract, which is expected to bring large-quantity follow-ons—including sales to England.

Navy Looking for ARM

Watch for a bidders conference to be called in the next month or two on a prospective Navy version of an antiradar missile (ARM). The bird could be built around the highly regarded passive radar guidance system developed for the defunct *Corvus* missile.

Scouting the Pole

First *Scout* shots from the Pacific Missile Range's Pt. Arguello will be to determine if the "gap" in the Van Allen belt really exists over the South Pole. The probes will measure radiation at a point about 40,000 miles over the end of the earth.

R&D Intelligence

Decoys being developed for the *Nike-Zeus* AICBM next year may look something like a child's "jacks" which will spring into shape when released from a reentry vehicle. . . . The Air Force's Aeronautical Systems Division is using a modified F-100F to simulate drag-lift conditions of advanced aerospace vehicles in an effort to eliminate need for long runways to accommodate *Dyna-Soar* and similar craft. . . . Convair is labeling every piece of hardware going into *Atlas* boosters for *Mercury*—a reminder to workers about quality control.

INTERNATIONAL

Ministerial Decision on Polaris

Any decision on whether NATO nations will buy *Polaris* missiles is being put off until the NATO foreign ministers' meeting in Oslo next month. The big question is whether the money would be better spent building up conventional forces. But hard-eyed military men see no chance of protecting Europe without nuclear weapons during the next few years.

Overseas Pipeline

Word is being spread that if Germany balks at supporting the European satellite launching program, Britain and France will go it alone. . . . France has gone through with its plan to make 61-year-old Gen. Gaston Lavaud a "czar" over all deterrent weapons development. And his first move has been to put SEREB—the country's missile "brain trust"—under his direct control.

Russian Promises

Soviet space scientists are promising to publish all the scientific information about their man-in-space flight —including possibly something on how it landed. What's more, they say that "in the future" foreign observers will even be invited to witness the return of Cosmic Ships.

when decision must race against time

Decision and control in today's military and governmental structure frequently must follow almost as soon as events occur. Yet the forces involved may span continents. And the information for control of these forces may be enormous in volume. ▪ To help leaders make decisions and exert control in response to events of the moment, we at System Development Corporation have helped create a new technology based on automated information processing assistance. ▪ SAGE is in operation as the first system of this new technology. Another—the SAC Control System—is in development. And we are working on two other extremely large systems in their initial stages. In contributing to these systems we have dealt mainly with their analysis and synthesis, training men in their use, instructing great computers on which they are based—and research into future generations of systems. ▪ We have developed an interdisciplinary approach to system development. The four fields are Operations Research, Engineering, Human Factors, Computer Programming. To staff our rapidly expanding programs in Santa Monica, California, Washington, D. C., and Paramus, N. J., we are seeking scientists and engineers in these fields. Please address Mr. R. L. Obrey, 2433 Colorado Avenue, in Santa Monica.

SYSTEM DEVELOPMENT CORPORATION

The Missile/Space Week

Shots of the Week:

Scientists are evaluating the first data on the density of neutrons in the upper atmosphere, telemetered from a *Blue Scout* April 12.

The shot was a forerunner of tests which may be able to detect high-altitude nuclear tests. The Geophysics Research Directorate of the Air Force Cambridge Research Laboratories and The Martin Co.'s Research Institute for Advanced Study (RIAS) designed the 10-lb. package.

Two sets of boron trifluoride detectors were used to measure neutron density in relation to altitude from 70 to 1200 miles. The capsule was not recovered because of stormy seas, but much of the data was telemetered during flight.

At Canaveral: A *Polaris* missile launched from a land-based pad tumbled into the ocean when the second-stage motor apparently failed to ignite.

Earlier in the week, a NASA space probe carried by a *Thor-Delta* rocket discovered the existence of a great solar "wind" sweeping outward from the sun into space at millions of miles per hour.

At Vandenberg: *Discoverer XXIII* obstinately refused to eject its capsule in the right direction and sent it further into space. The ejection command was given after a record 1.5-million-mile trip through space.

Somewhere in space: *Echo I* continued to stump the experts by going up instead of succumbing to atmospheric drag as had been predicted. Slight pressure from sunlight acting on the satellite's great bulk and light weight has helped to keep it aloft, scientists now theorize.

Council Bill Progress

The House Space Committee has approved President Kennedy's bill to make the National Space Council "active and useful" and put Vice President Lyndon Johnson at its head.

The bill reduces the council's membership from eight to five—the vice president, secretaries of state, and defense, the AEC chairman and the NASA administrator.

Dr. Edward C. Welsh, new executive secretary of the council, said a small but technically well-qualified council staff will be chosen soon.

Transit Cost Set

The Navy's *Transit* satellite system, capable of providing a world-wide ship navigation system, will cost the government about $3 to $4 million yearly.

Capt. Robert F. Freitag, astronautics chief of BuWeps, also told the House Space Committee that the Navy is seeking to reduce the weight of the satellite from 260 lbs. to 100 lbs.—cutting launching costs to between $750,000 and $1 million. It also hopes to extend the lifetime of the *Transit's* electric gear from six months to from three to five years by using solar batteries.

Sidewinder Tragedy

All training maneuvers with airborne missile systems have been discontinued until the Air Force finds out what triggered the *Sidewinder* missile that shot down a B-52 bomber April 7.

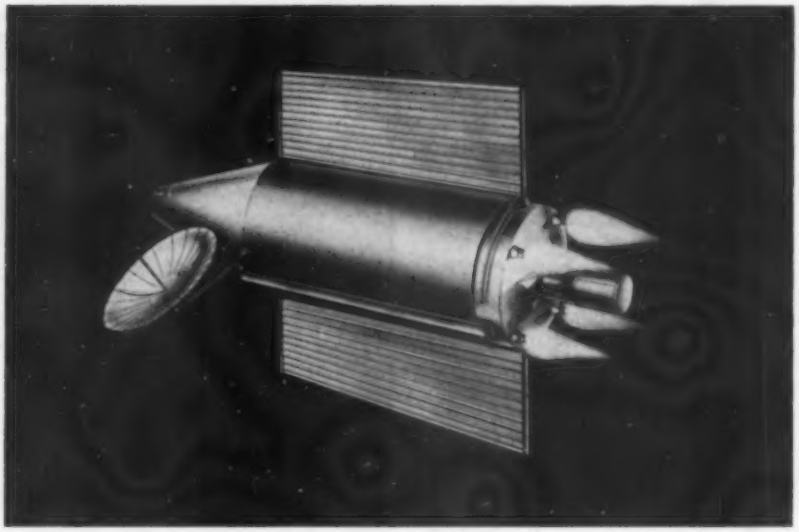
The incident, which occurred over Mt. Taylor, New Mexico, took the lives of two crewmen. Five parachuted to safety and were recovered.

The missile was unleashed from a F-100 fighter plane engaged in routine "war games" with the B-52. The nearly half-dozen separate safety checks needed to make the heat-seeking missile "safe" were said to have been made.

A-G Standardizes Segments

Solid booster segments, 100 in. diameter and 11 ft. long, ultimately capable of 1 million pounds thrust with current propellants were presented to NASA and DOD last week by Aerojet-General. The segments can be joined in 97 seconds through a unique push-on coupling method. Sealing involves a rubber gasket and a simple steel rod.

The economical approach to big boosters faces only one more hurdle—thrust vector control—before quantity production is feasible. Aerojet says this can be solved in six or eight months from a variety of concepts including jetavator variations, swiveling nozzles and gas or liquid injection from points in the nozzle throat.



Spin-Away Spacecraft

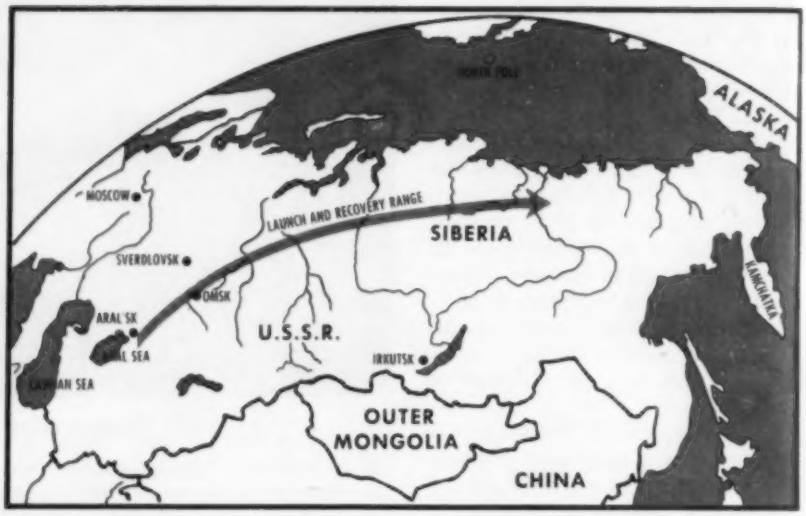
ARC JET-PROPELLED space vehicle concept by Avco incorporates four thrust units using hydrogen as propellant. Vehicle would be launched with chemical rocket boosters into low-altitude circular orbit. After separation, spacecraft would spiral away and could ultimately reach a 24-hour or lunar orbit.

←——Circle No. 30 on Subscriber Service Card

first man in orbit . . .

Did Soviets Gain Giant Military St

- ***Next Red Manned Space Shot expected shortly***
- ***Landings on the moon appear to be the next major objective***
- ***Will Kennedy be forced to alter U.S. program?***
- ***Major blow dealt U.S. diplomacy in Asia and world trouble spots***



ALMOST POLAR orbit carried the Soviet cosmonaut over South America and Africa. Arrow indicates approximate launch area at 65°4' inclination.

by James Baar

RUSSIA'S manned *Cosmic Ship IV* appears to have given Russia a giant lead in developing a winged military spacecraft—along with winning the world's laurels for beating the United States in the race to put a man in orbit.

At the same time, *Cosmic Ship IV's* historic flight:

—Brought renewed forecasts from top Soviet space scientists that Russia was pressing on toward early landings on the moon before the United States. They said another Soviet astronaut would be launched into space as soon as possible after examination of data from the first flight is completed. There also was talk of launching a Soviet space station.

—Forced into the open that the Kennedy Administration for the most part has adopted at least temporarily the "step by step" space policies of former President Eisenhower.

—Dealt a stunning propaganda blow to U.S. prestige throughout the world—particularly in Africa and Asia.

Key congressmen reacted cuttingly and unhappily to the latest Soviet space triumph. Several warned of dangerous military implications. But there was no immediate indication how hard they would fight to force through a greatly accelerated space program.

• **'A solid program'**—President Kennedy and NASA Administrator James Webb sought to ward off such a move with calming statements.

"As I said in my State of the Union message," Kennedy said, "the news will be worse before it is better and it will be sometime before we catch up."

Webb said the United States has "an orderly step-by-step program that will give us a basis for sound scientific achievement." Deputy Administrator Hugh Dryden echoed his words.

"The Soviet launching represents a technical accomplishment," he said. "We have of course been expecting the day for a very long time. We ourselves have formulated a program to meet the needs of the country, a solid program moving forward step-by-step."

Webb said that the United States might if it wanted have a Manhattan District-type program aimed at faster results. But he said that was up to the country and Congress.

"Our present program is more economic and sounder for scientific development," he added.

He made clear the Kennedy Administration had no immediate post-*Vostok* plans for increasing U.S. space efforts beyond the relatively modest increases already announced.

• **How word came**—Moscow Radio made the first announcement of the launching of *Vostok* at 2:05 A.M. EST.

"The world's first spaceship, *Vostok*, with a man on board has been launched on 12 April in the Soviet Union on a round-the-earth orbit," it said.

"The first space navigator is Citizen Pilot Major Yuri Alexseyevich Gagarin. Bilaterial radio communications have been established and are being maintained with Gagarin. He feels well."

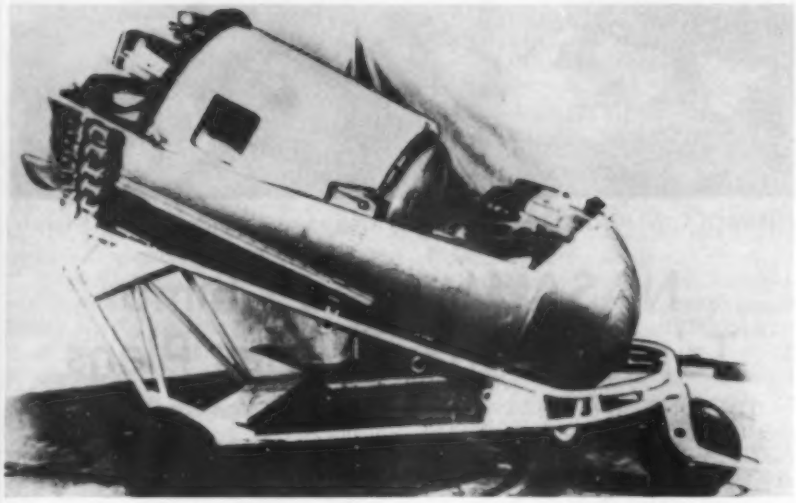
Then, according to Moscow Radio, the 10,460-lb. *Cosmic Ship* completed one orbit around the earth and landed at an undisclosed point in the Soviet Union. Its perigee was reported to be 109.5 miles; its apogee, 187.75.

The orbit, which was in a 65 degree, 4 minute inclination to the equator, took the *Vostok* and its pilot over Africa and South America. The orbit's period was 89.1 minutes. The complete flight from blast-off to landing took 108 minutes.

The Russians reported that the 27-year-old Gagarin landed safely on the "sacred soil of our homeland, the land of the Soviets." Then, while Russians poured into the streets of their major cities to celebrate, Gagarin was examined by scientists who had watched him during the flight by TV—as they had watched the dogs who preceded him. They said he showed no ill effects from the strains of the trip, including the more than an hour of weightlessness.

The White House disclosed that the U.S. worldwide radar net had tracked

...ry Step With Winged Spacecraft?



FIRST successful recovery from orbit by Soviets was Cosmic Ship II. It carried 2 dogs and other biological specimens on launch last Aug. 19.

the *Vostok* throughout its flight. Presidential Press Secretary Pierre Salinger said he was informed of the launching at 1:30 A.M. EST—35 minutes before it was announced by Moscow Radio.

• **Winged implications**—The Russians did not disclose the configuration of the *Vostok* nor the method by which it re-entered the atmosphere and landed, probably in Kazakh east of the Aral Sea. However, informed sources said data considered reliable strongly indicated that the *Vostok* ejected a winged capsule that was landed as an aircraft.

Acadamecian Anatole Blaganravov, a leading official in the Soviet space program and a Red Army lieutenant general, gave support to the report.

'We Are All Asleep'

A reporter called Lt. Col. "Shorty" Powers, press officer for the U.S. astronauts at Langley AFB, Va., to inform him the Soviets had a man in space.

"It's 3 a.m. in the morning, you jerk," Powers shouted into the phone.

When the reporter suggested that despite the hour he would still like the views of the astronauts, Powers retorted:

"If you're wanting something from us, the answer is we are all asleep."

He said at a hastily summoned press conference at Florence, Italy, that although he had no specific information he assumed that the *Vostok* was recovered "by a combination of parachute and glider." He also revealed he had just been in contact with Moscow.

The implications were decidedly unpleasant.

Until now, the Soviet *Cosmic Ships* have been publicly regarded by both the Eisenhower and Kennedy Administrations as only king-size *Mercury* capsules. On this assumption, the *Vostok* only outclassed the 2500-pound U.S. *Mercury* capsule in weight and time.

But, as a winged spacecraft, the *Vostok* would be ahead of *Mercury* by a generation and in a class with the U.S. *Dyna-Soar* R&D program and the NASA *Apollo* study program.

Air Force officials and others have been warning for some time that the Soviets plan to develop a military space force and that the United States must develop offensive and defensive military space weapons. A winged *Vostok* points clearly in this direction.

Only 48 hours before Gagarin's flight top Air Force officials warned the Senate Armed Services Committee at a closed hearing that Russian space programs aimed at control of space could jeopardize the Free World's security.

The Eisenhower Administration repeatedly rejected this point of view. So far, the Kennedy Administration has indicated recognition of a military space threat but relatively few dollars have been forthcoming to do much about it.

The winged *Dyna-Soar* which is the country's most advanced hope of developing a true military spacecraft has been starved for funds for years and there were repeated delays on even getting it underway.

Through FY '61 a total of about $100 million has been committed to it. The final Eisenhower defense budget added another $70 million for FY '62. Kennedy in his budget revisions added another $30 million instead of the approximately $100 million sought by the Air Force.

Apollo, which is a civilian version of a winged spacecraft, has faired far worse. In fact, it hardly exists except in paper announcements and a few advanced studies.

The Eisenhower Administration put $29.5 million in its final space budget for a group of advanced space vehicle studies directly and indirectly applicable to *Apollo*. Kennedy added $125 million to the NASA budget mostly for speeding up work on propulsion programs, but he added nothing for *Apollo*.

As for other military space projects, Kennedy added money for warning and communications satellites but little new money was requested for advanced offensive and defensive space systems.

The alarm of congressional leaders over Gagarin's flight was best illustrated by Chairman John C. Stennis (D-Miss.) of the Senate Preparedness Subcommittee.

• **Weapon potential**—He said if a man can be orbited and recalled "it can be done with a weapon—with a whole lot of weapons simultaneously." He said consideration should be given to psychological impact and strategic implications of such a Soviet weapon system.

Chairman Richard B. Russell (D-Ga.) of the Senate Armed Services Committee said he thought the military implications of Gagarin's flight are not as significant as the implications for future space exploration. However, he also said the Soviets could be moving toward the development of a military

(Continued on page 39)

Soviet Aim Appears to be Man on Moon

RUSSIA'S SPACE program is now assuming a pattern which appears directed squarely at putting a man on the moon in the next few years.

Technical observers in the West note that the Soviets adhered tenaciously to a single concept in orbiting the first man in space. They are now broadening their program as it matures—in marked contrast to the U.S. program which has never developed any hard-and-fast goals.

There is evidence that some time before the Soviets opened the Space Age on Oct. 4, 1957, with *Sputnik I* they were planning to orbit a man. They obtained their first real knowledge that it would be possible with *Sputnik II*—just 30 days later. The second satellite containing the dog Laika apparently convinced the Russians that weightlessness, among other things, would not be a problem in orbiting a man for short periods.

Approximately 2.5 years later, on May 15, 1960, the Russians orbited a "space cabin" but failed to bring it back. This apparently did not represent a real obstacle because within three months a similar space cabin containing two dogs and other assorted creatures was successfully returned—and at a predetermined spot.

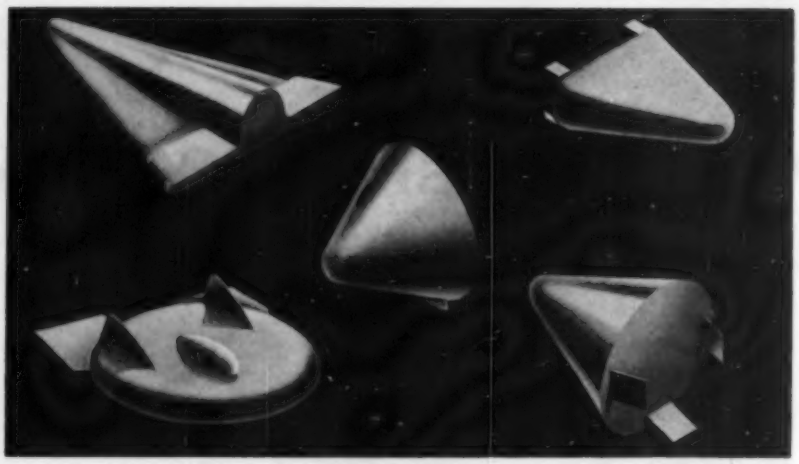
Once again, in December, 1960, a second space cabin failed to re-enter. The fourth space cabin carried Major Gagarin around the world and back to earth without incident.

• **Giant strides**—It is evident that *Sputnik II* answered quite a few questions. In the ensuing 30 months before the first launching of a space cabin in May, 1960, the Russians solved the major problems inherent in manned orbital flight, designed and built a vehicle, incorporated communications, guidance and the rest of the necessary paraphernalia and mated it to a booster.

There is only speculation concerning any possible failures during this period. It is not inconceivable that there might have been some, but it is obvious that the program did not appreciably falter.

The series of firings by the Russians in the Pacific were probably an integral part of the man-in-space effort.

(Continued on page 39)



POSSIBLE CONFIGURATIONS of Apollo orbiting space laboratory under NASA study.

NASA May Cut Chimp Trip in Mercury Atlas Plans

THE UNITED STATES may be able to cut one step—an orbital chimpanzee flight—from Project *Mercury* development plans as a result of the successful orbital flight of Soviet cosmonaut Gagarin.

The Soviet success may also make it easier for the National Aeronautics and Space Administration to convince President Kennedy and Congress that it ought to have money to start hardware work this year on the *Apollo* three-man orbiting space laboratory, now targeted for flight in 1965 or 1966, thus advancing the funding by a full year.

Meanwhile, plans moved forward for the first manned suborbital flight, possibly during the last week of April. Dr. Hugh L. Dryden, NASA deputy administrator, said the earliest possible date is April 28.

High NASA officials maintain that it will be very difficult to speed the *Mercury Atlas* orbital program to any great degree. Three major intermediate milestones now are on the schedule before manned orbital flight. They are:

—Injection of the capsule into an orbital trajectory and immediate command of re-entry.

—Orbiting and re-entry of a capsule without passengers.

—Orbiting and re-entry of a capsule containing a chimpanzee.

Goal of the first test in the series—scheduled possibly in the next few weeks, is to prove out a fix in the *Atlas* forward section and to make the first *Mercury* re-entry experiment. The second is to accomplish re-entry from orbit. The final test is designed primarily to determine how a creature resembling a man withstands weightlessness for the time required for orbital flight.

However, since Gagarin has apparently demonstrated that weightlessness is no problem—at least during the period of one orbit—high NASA officials will consider dispensing with the chimpanzee-in-orbit test.

Compression of the plans would not mean that only two *Mercury Atlas* flights would precede the orbital attempt, even if both were successful. High NASA officials emphasized the necessity of repeatability in achieving re-entry from orbit before risking the life of a man.

• **Appeal for Apollo**—It was understood that NASA is preparing a new appeal for funds for hardware work on the *Apollo* capsule. A high administration source said that President Kennedy merely postponed the request for *Apollo* funds, but did not rule out making such a request before the end of the current Congressional session. Informed guesses were that about $50-$60 million would be involved for FY 1962.

Space Administrator James E. Webb told reporters he assumes the President will take under consideration the question of experiments in parallel, so as to buy time. The present *Apollo* program is on a step-by-step basis, he said. Webb said parallel work would be more expensive and there are some scientific objections to it.

Scheduling of the manned *Redstone* flight depends on the success of a *Little Joe* test, probably this week, in which the capsule escape system will be given its final checkout. It also depends on successful completion of air-drop tests of the capsule landing bag. ⠿

Lockheed proposal . . .

Syndicate for Communication System?

by Jay Holmes

AN INDUSTRY syndicate, organized as a "common carriers' common carrier," is emerging as the most likely organization of the ultimate operational communication satellite system.

High officials of the Kennedy Administration are looking with favor on the idea, first advanced by Lockheed Aircraft Corp., under which all users of the satellite facilities would jointly own and operate the network.

Less than a month after the Administration took office, Lockheed obtained word from the Justice Department that the government would not proceed under the criminal provisions of the antitrust laws against such a combine—provided that organizers keep the government informed every step of the way. The assurance did not rule out the possibility that the government might act under the civil provisions of the antitrust laws if it is not satisfied with the way the syndicate takes shape.

Lockheed advanced the idea on March 1, in a lengthy brief filed with the Federal Communications Commission. The plan gained favor as an alternative to the plan originally advanced by former NASA Administrator T. Keith Glennan, under which a single company would have paid the government the cost of launching experimental communication satellites.

Lockheed said its plan is based on the assumption that operation of satellites by private enterprise is commercially feasible beginning in the 1966-68 period—and technically feasible sooner.

• **Plans cancelled**—The question of monopoly is regarded by the new administration as the stickiest in the area of communication satellites. Officials of the Federal Communications Commission feel that it isn't practical to set up a number of competing satellite systems because of the immense cost involved. Thus they reason that some solution must be found to the problem posed by the antitrust laws.

As a result of the policy questions involved, Space Administrator James E. Webb cancelled plans in the Eisenhower administration budget for the government to receive $10 million from private industry as payment for launching an experimental satellite during Fiscal Year 1962. Webb told the House Space Committee last week he still assumes that industry will take part in developing the operational system. He added that NASA plans to go ahead with its own research and development plans, but that the government will pay the whole bill in the coming year.

Under the previous administration, the American Telephone and Telegraph Co. had proposed to enter negotiations with the government on plans to have the government launch its satellite within the next year or so. On Jan. 19, the last full day of the Eisenhower Administration, the FCC granted AT&T permission to use the 6325-6425 mc and the 4100-4200 mc bands for its experiments.

Some industry quarters maintained that the AT&T plan might lead to a space communications monopoly. The company denied this, saying that the system would be operated under government regulation and that service would be available to all comers, just as in the operation of present commercial communication systems.

The Lockheed plan calls for the private group—of which Lockheed would be the operating agent—to launch the satellites on behalf of the common carriers. It is in competition with proposals in some quarters—still rather nebulous as to detail—under which the government would be the launching agent.

There is also some question about whether it would not set Lockheed in a monopolistic situation on component manufacture. The argument is being

NASA's Communication Satellite R&D Schedule

PROJECT	SPACECRAFT	LAUNCH VEHICLE	TRAJECTORY	LAUNCH PLANS
S-3	Radiation experiment package weighing 85 lbs.	Delta	Elliptical orbit—a few hundred to 30-40,000 miles	Third quarter 1961
ECHO II	135-ft. rigidized sphere; weight 500 lbs. plus 100-lb. container	Thor	Suborbital—to 7-800 mile altitude, 600 miles downrange	Two shots: last quarter 1961 and first quarter 1962
ECHO II	Same	Thor-Agena B	700-mile orbit	Second quarter 1962
RELAY	Active repeater, weight 85 lbs.	Delta	1000-3000-mile orbit	Two shots in 1962
ARENTS	NASA-DOD payload including "piggyback" S-3	Centaur	22,300-mile circular equatorial (24-hour) orbit	Three shots planned in 1962 and 1963
RELAY-ADVANCED	Two Relays in one payload	Atlas-Agena B	5000-6000-mile orbit	Not set
REBOUND	Three Echo II's in one payload	Atlas-Agena B	Circular orbit 1500-2500 miles	Mid-1963; backup available
REBOUND-ADVANCED	Six Echo II's in one payload	Centaur	Circular orbit 1500-2500 miles	1964; backup available

made that joint ownership solves the problem of communications monopoly, but not in the area of launching vehicle manufacture. However, there seems to be no serious question that a single company or agency would actually handle launchings, whether for the government or for a commercial syndicate.

• **Chairman intent**—Newton H. Minow, the new chairman of the FCC, told M/R, "I regard the problem of communication satellites as one of the most central and urgent we have to deal with in the 1960's."

The 35-year-old Minow, a former law partner of Adlai E. Stevenson, pointed out that the Communications Act under which FCC operates requires the commission to encourage private enterprise to advance the state of communications technology in every way possible. It follows, he said, that the commission has a duty to support efforts by industry to enter the satellite field as soon as practical.

The commission has asked industry to file briefs by May 1 discussing the antitrust question.

T. A. M. Craven, a holdover FCC commissioner from the Eisenhower Administration—who also served a seven-year term under Franklin D. Roosevelt, said he disagrees with Webb's decision on industry participation. If he had his way, Craven declared, a private company or group of companies would be given a go-ahead within the next few months. However, Craven said he expects the Webb decision will be merely a delay in the ultimate decision to go ahead with industry participation.

Some stir has been caused by the problem of overlapping military and civilian jurisdiction in the area of communication satellites. This will be one of the issues given to the National Aeronautics and Space Council, to be headed by Vice President Johnson.

But the question of division of space between the private and government sectors must be settled by negotiation. The same is the case between military and civilian agencies within the government. The FCC chairman declared that someone should be put in charge.

Leonard Jaffe, NASA chief of communication satellites, emphasized in an interview that a great deal of research and development will be necessary before a system can become operational. However, he said the question of timing is for the ultimate user to decide. NASA's job is to advance the state of technology, leaving to others the question of when the technology is commercially feasible.

Jaffe outlined a NASA program of research beginning with test flights of a rigidized 135-ft. balloon satellite late this year and continuing through multiple launchings of six at a time by 1964. One of the most important phases of the program, he said, is the NASA satellites for measuring radiation in space—the next of which will be the *S-3*, launched in the third quarter of this year. ¤

Fuel Cell Uses Bacteria to Produce Power

A BIOCHEMICAL fuel cell developed by government scientists is tabbed by many experts as one of the most significant advances yet made in energy conversion.

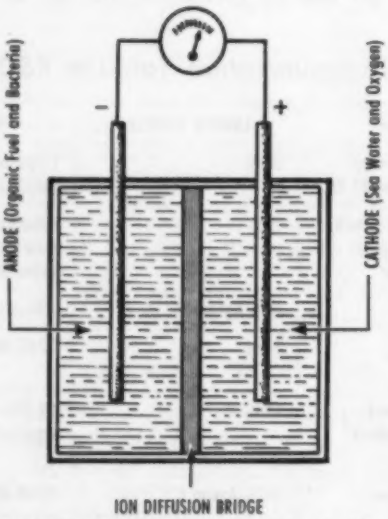
The cell, developed by Dr. Frederick D. Sisler, Department of the Interior Geological Survey biochemist, produces electricity directly from the decomposition of organic matter.

Dr. Anthony Moos, vice president of Leesona Corp. and an authority on energy conversion, said the development is "extremely significant." This is true, Dr. Moos noted, not only because the cell uses cheap and available fuels and oxidant, but also because its production of electrical power marks the first use of biochemistry for providing anything other than man's basic needs of food, shelter and clothing. Hence, the door is opened to a new utilization of biological systems for the service of man.

Although not tied to any particular application, the biochemical fuel cell could be important in space as well as on earth.

• **Clue from deep**—Dr. Sisler based his work on the observation that ocean-bottom sediments and their overlying sea water act as a gigantic fuel cell. Under natural conditions, the energy produced by such a process is dissipated as heat. (The heat generated in the middle of a compost pile is a similar example.)

The primary feature of the new cell is its use of abundant and inexpensive materials as fuel and oxidant. The prototype unit is composed of two sections containing inert electrodes—an anode section and a cathode section—separated by an ion-diffusion bridge. The anode section contains a mixture of sea water and organic matter as fuel, and bacterial cells (or enzymes) as a catalyst. The cathode section contains sea water and oxygen. The energy released comes from bacteria "burning" the organic matter, but the energy is released as electricity rather than as heat.



LABORATORY PROTOTYPE of biochemical fuel cell produces electrical energy directly from decomposition of organic material created through photosynthesis and biological processes in sea water.

Sisler says an inexpensive supply of both oxygen and organic matter for fuel can be obtained by placing live algae in the cathode section. Such a cell, containing inorganic salts, bacteria cells and algae, could conceivably produce electricity indefinitely from solar energy alone. In addition, a great variety of otherwise practically useless organic materials could be used as fuel in place of solar energy and converted directly to electricity.

Survey scientists estimate the efficiency of the biochemical fuel cell to be equal to or higher than that of the most advanced types of conventional powerplants (35-40%). They say that a much-higher-efficiency biochemical cell can probably be developed which could result in a revolutionary source of power for specialized and industrial use. According to Sisler, such use would probably be limited to intermediate load and voltage applications.

The research was funded by Geological Survey and, until now, has received no military support. The Army Research Office—which has DOD cognizance of fuel cell programs—is interested in the potential of the device and will probably back further development. The Signal Corps has also expressed interest in pursuing the work. It is understood, although not confirmed, that the Navy is supporting an extensive program in biochemical energy conversion. ¤

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What is a KIN TEL Closed Circuit TV system?

The basic KIN TEL closed circuit TV system consists of a camera, camera control unit, and monitor, each connected by cable. The camera can be located at great distance from the monitor, and any number of monitors may be used to display the same picture.

Cameras are small enough to hold in your hand; rugged enough to operate in virtually any environment; versatile enough to cover (via remote control) almost any area; and sensitive enough to provide excellent pictures of subjects illuminated by a single candle.

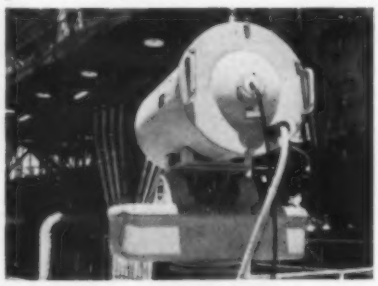
The camera control provides automatic operation. The system is continuously self-adjusting for wide variations in light levels (several thousand to one), and features automatic high definition of bright objects. The only control you have to touch is the on-off switch.

The monitor displays a crisp, clear picture...full 650-line resolution, twice that of the best home TV reception.

How are such systems used?

Today, KIN TEL TV systems are performing a number of jobs for *hundreds* of firms, safely, inexpensively, tirelessly.

They are being used to watch operations or events that are tedious, difficult, dangerous, or even impossible for men to watch.



For example: Convair (above), Douglas, Lockheed and Northrop watch rocket tests with KIN TEL systems. U.S. Steel uses one to see inside open hearth furnaces. Westinghouse watches nuclear power reactor tests with one.

They are being used for surveillance.

For example: The San Francisco Naval Shipyard uses one to guard against pilferage.

They are being used for traffic control.

For example: The Alameda Naval Air Station uses a KIN TEL TV system to observe aircraft landings on the portion of the runway that is not visible from the control tower.

They are being used to transmit visual information quickly and accurately; for remote observation of charts, meters, graphs, schedules, blueprints, photographs, images from microscopes, fingerprints, signatures...the list is almost endless.

For example: E. F. Hutton uses a KIN TEL system to transmit stock market quotations to the offices of the firm's executives. The Los Angeles Department of Water and Power uses one for remote viewing of water-level meters. The University of California teaches physics with one.

They are being used for monitoring any operation that normally requires standby personnel.

For example: American Potash and Chemical (above) monitors conveyor line and warehousing operations with a KIN TEL TV system.

Why do these firms choose a KIN TEL system?

For a variety of reasons.

First, *reliability.* KIN TEL TV is designed for continuous duty operation in severe environments. Day in and day out, it keeps working. It's the first choice for ICBM and other missile programs that really depend on TV, that can't chance failure, that can't afford to compromise with reliability.

Second, *picture quality.* KIN TEL TV presents clear, sharp pictures. Full 650-line resolution provides maximum data...essential for *quantitative* observation of complex operations or transmission of printed material.

Third, *automatic operation.* KIN TEL TV is the only closed circuit system that provides entirely automatic, through-the-lens compensation for light-level changes of several thousand to one.

Fourth, the KIN TEL closed circuit TV system is extremely *sensitive.* The light required to read this page is enough for sharp clear pictures, and usable pictures can be provided with less than one-foot candle illumination.

Fifth, KIN TEL TV systems are *easy to install* and *simple to operate.* With no changes in lens iris to make, with no difficult, interacting electrical adjustments required, the only thing the operator has to know is the location of the on-off switch.

Sixth, a *complete* line of shelf-item system components and a variety of cameras and monitors make virtually any application feasible...permit observation of nearly every kind of operation, under all kinds of conditions.

For example, with system components, you can remotely position the camera, remotely select one of several lenses, remotely "zoom" in or out for closeup or wide-angle viewing, operate the camera in extremes of temperature or in explosive or dusty atmospheres, view microscope images. Whatever your viewing problem, KIN TEL probably has a *stock* solution.

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What can a KIN TEL system do for your business?

It can do what it is doing right now for hundreds of other firms. It can save you time and money...increase efficiency...better your service to clients and customers. To find out how, write direct for catalog 6-205 and the name of your nearest KIN TEL engineering representative.

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Any piece of sky can be the launching pad for Skybolt air launched ballistic missile. This radically new deterrent weapon is designed to have global mobility. It will be carried, and launched in flight, by the USAF B-52, or RAF Vulcan. When it becomes operational, four Skybolts may be launched from the same B-52 to strike multiple targets up to 1000 miles away. The very existence of such a flexible retaliatory force will be a formidable deterrent.

The stellar-monitored inertial guidance system for the USAF-Douglas Skybolt is being developed and built by Nortronics.

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Technical Countdown

ELECTRONICS

Electronic Circuits Survive High Radiation Levels

Recent nuclear radiation tests show that most electronic circuits can be expected to operate satisfactorily under high radiation levels in nuclear-powered aerospace vehicles. Twenty out of 24 representative circuits successfully operated after a 100-hr. exposure to 5×10^{16} neutrons/cm^2. The only transistor circuit in the test failed before the reactor was brought up to full power. All other circuits contained glass or ceramic tubes. Chance Vought conducted the experiments for the Air Force.

MM Computer Poops Out, Finally

Autonetics finally ran a *Minuteman* guidance computer to death. Started in mid-1959, the solid-state digital system has been operated for over 12,000 hours with no major breakdowns, the NAA division said. None of the super-reliable electronics components which some day will be used in the system were employed in this life-test device.

Minified Guidance Passes Tests

Litton Systems Inc. has just successfully sled-tested its new inertial guidance package. The 30-lb. P-200 stable platform used is half the size and weight of comparable units in today's missiles. Litton said the 80-lb. inertial system has passed all environmental tests, as well as centrifuge and sled tests—both with peak sustained accelerations of over 10 g.

Solar Cell Measurements Up to Manufacturers

Bureau of Standards says that complaints of lack of standards to measure solar cells efficiencies are unfounded. They point out that the standards are available, and the problem is that manufacturers must agree on measurement procedures.

Russians Also Have Ions in the Fire

A conference on theoretical, experimental and applied aspects of magnetohydrodynamics held in Riga drew over 100 papers, the Russians report. Plasma physics came in for special attention. The Institute of Physics of the Latvian Academy of Sciences—described as a major center for MHD studies—presented most of the papers on applied aspects.

SUPPORT EQUIPMENT

AF Study Aimed at Better Checkout Systems

A 14-month study by Battelle Memorial Institute is expected to lead to better automatic weapon system checkout equipment. Results of the Air Force study will be available to designers to help them better understand the basic problems associated with the checkout of missiles at the operational level.

Long-Sought Librarian Found

A microfilm storage-data retrieval-printer system has been developed which can locate and print information at a rate of 6400 pages/minute. Called Filesearch, it was built by FMA, Inc., in El Segundo, Calif. A single unit accommodates 1.6 million pages of data and employs electro-optical techniques for retrieval. Cost: $100,000 plus.

Converter Ties Computer to Checkout System

A digital interface converter which ties together a general-purpose digital computer with standard test stimulus and measurement blocks to form an integrated checkout system has been developed by RCA. The converter allows use of existing high-speed computers, on a time-shared basis, to provide arithmetic and programing functions for testing.

Stretch Computer Completes Tests

Pre-shipment reliability tests on the IBM Stretch computer have been completed, and Los Alamos Scientific Laboratory expects to have the "super computer" installed and operating by early summer. The computer exceeded its reliability specifications by a considerable margin. Stretch, whose development began in 1955, will handle "floating point" calculations 20 to 30 times faster than the IBM 704.

Soviets Develop Helium Machinery

Two new machines for producing liquid helium are entering the Soviet research effort. One machine, now in production, produces 1.45 gallons of liquid helium an hour. Liquid nitrogen is used to cool the apparatus during operation. Another machine, still in the experimental stage, produces almost four gallons an hour without need for nitrogen cooling. The Russians say the efficiency of both machines is greatly increased with use of plastic pistons and valves.

ASTRONAUTICS

Oxygen-Maker Developed for Space

A working prototype of a system to convert an astronauts' breath into reusable oxygen has been built for the Air Force. The system converts CO_2 into carbon and water. It is designed to operate continuously on space voyages lasting as long as three years.

Fifty Miles Probable Ceiling on X-15

The *X-15* has enough propulsive power to carry it well above 50 miles, reports NASA Deputy Administrator Hugh L. Dryden. The question is whether it can be brought down safely from such an altitude. The skin, nose, and wing leading edges are designed for a maximum re-entry temperature of 1200°F. The rocket plane will be programed for gradual increases in altitude until the temperature reaches 1200°. It's unlikely such a flight will carry it above 50 miles. So far, temperatures of 500-600°F have been recorded on flights up to 32 miles.

ADVANCED MATERIALS

Corrugated-Core Sandwich Panels Developed

A roll-welding process which uses hot rolling for pressure-welding peaks of corrugated metal cores, to cover sheets without jigging, has been developed by metallurgists at Battelle Memorial Institute. The panels can be extensively formed after assembly; then the V-shaped inserts are leached out. The cost-cutting method has been successfully applied to 2014 Al alloy, B-120 VCA titanium, unalloyed A-55 titanium, steel, molybdenum and Inconel.

Cryogenic Radiation Investigated

The effects of nuclear radiation on metal alloys at −423°F are being studied at Convair-Ft. Worth. Titanium, stainless steel and aluminum alloys are involved in the program. The results will be applied to nuclear-powered rocket engines using liquid hydrogen as a working fluid.

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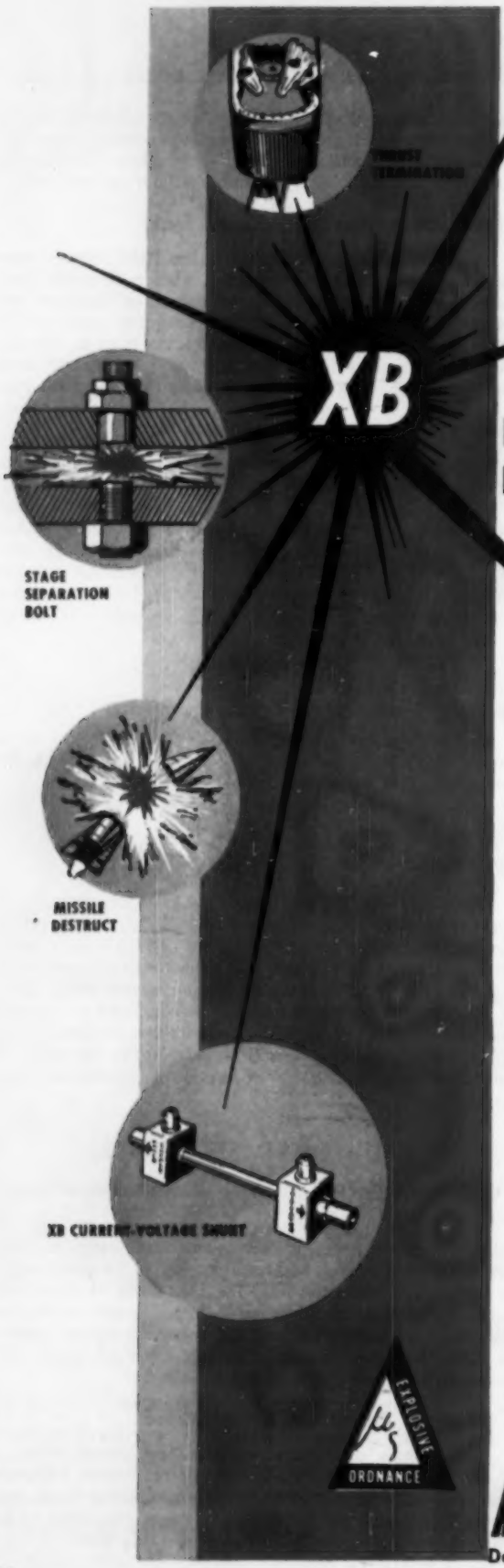

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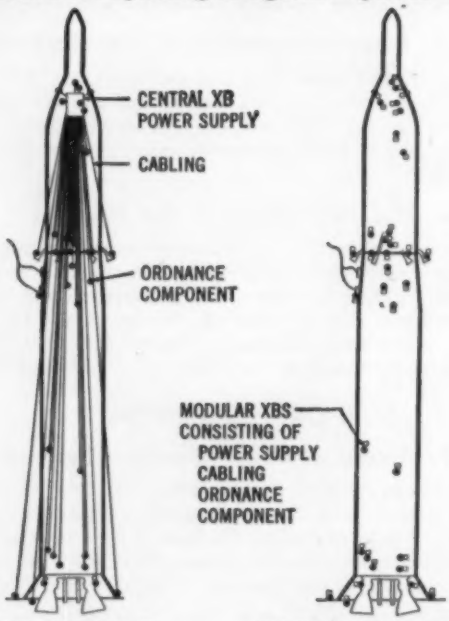
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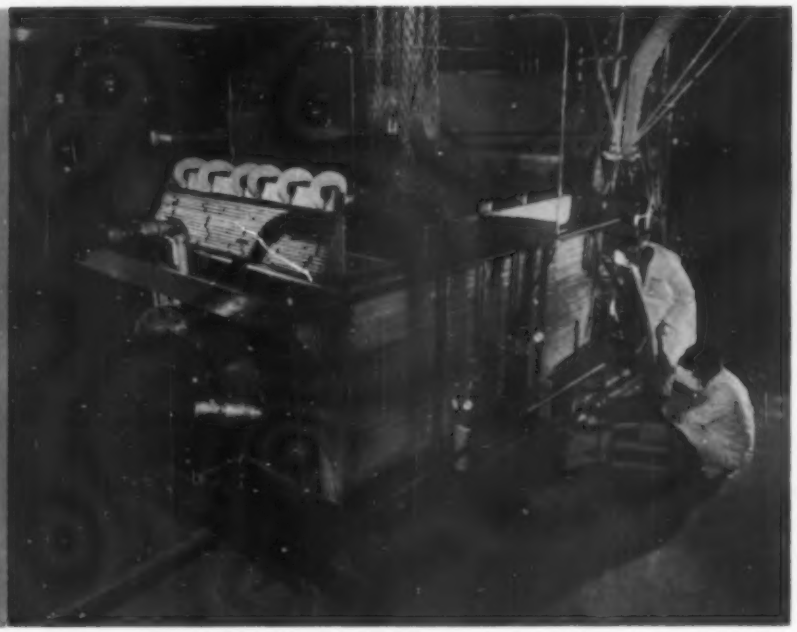


ELECTROMAGNET of Mark II experimental MHD generator is made of 25-ton pole pieces and 22 tons of copper plates connected to form coil. Magnetic field is formed across channel running through center of magnet. Power is delivered to loads through two sets of cables (upper left). Pipe (lower left) carries off exhaust gases.

MHD Power Experiments Top Results Expected

by Hal Gettings

RESEARCH in magnetohydrodynamics (MHD) for commercial power generation is paying off a lot better than expected.

The first year of research with an experimental generator has produced power levels and efficiencies much higher than was thought possible a year ago.

The successful production of 205 kilowatts of power is 20 times the level produced when the project was first announced, in late 1959. Further development of the new generator is expected to bring the output level up to 500 kw for short periods. Earlier estimates that efficiencies of powerplants could be improved by 25% have been upped to 40%.

Avco Everett Research Laboratory is conducting the experimental work, in association with a group of electric utility companies. The initial successes have caused the group—called American Electric Power Service Corp. (AEP)—to triple its current research budget to $1.2 million. Ten companies joined with Avco when the project began; two more have been added recently.

• **Result of space research**—Techniques of MHD power generation are a direct fallout from research in missile/space projects. Avco, a leading R&D defense contractor in re-entry physics under the leadership of Dr. Arthur Kantrowitz, has studied MHD for power and space propulsion for the past four years. Knowledge gained in this work and associated areas of plasma physics is now being turned toward commercial applications.

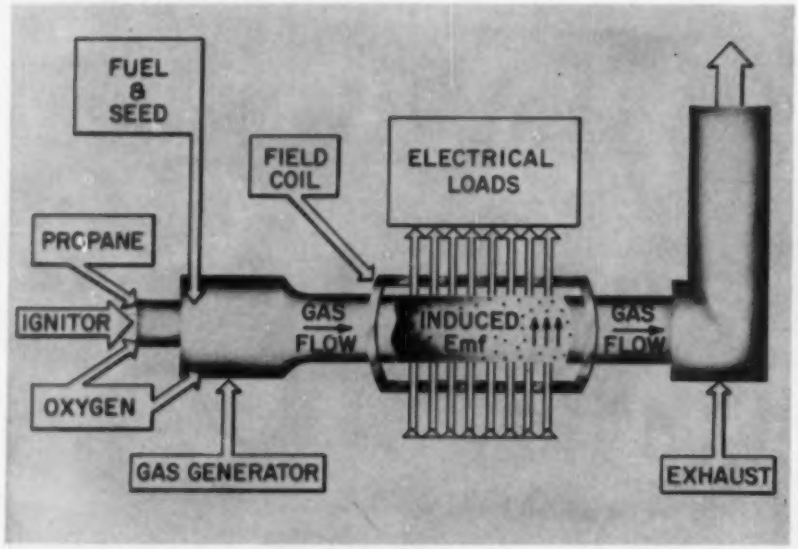
The research group's enthusiasm for the possibilities of MHD is practically boundless. Philip Sporn, president of AEP, says that MHD "is probably the most exciting area of development in power generation today" and the program "has yielded results more favorable than we could have reasonably expected at the end of 1959."

• **Materials problem**—One big reason for the enthusiasm is the fact that the past year's studies solved one of the major problems in MHD: materials vs. temperatures.

Temperatures in excess of 4000°F are required before combustion gases can become conductors of electricity. Hence it was necessary in the original power cycle to preheat the combustion air above 3000°F for efficient operation of the MHD plant. There are still no materials capable of withstanding such temperatures.

To solve the problem, Avco and AEP studied power cycles in which the combustion air is enriched with oxygen before being fed to the preheater and combustion chamber. The use of oxygen reduces preheat requirements to the point where a conventional material, such as stainless steel, can be used. The new cycle yields performance and economics comparable to those of the original air cycle. Use of an "oxygen cycle" means that commercially available regenerators (preheaters) can be used in the MHD system; a new regenerator design is not necessary. Therefore, only the generator itself requires further development.

• **Eliminates two moving parts**—The basic principle of the MHD generator is the same as that of a con-



FUEL AND OXYGEN are burned in MHD power generator to produce high-temperature (5000°F) electrically conducting gas. Ionization of gas is increased by seeding with a potassium salt. The ionized gas flows down channel and through magnetic field, creating electric voltage. Power is tapped off on electrodes attached to inside of channel.

ventional generator: an electrical conductor moving through a magnetic field generates a voltage. The conventional generator uses a solid conductor (armature) driven by a turbine, while the MHD device uses a stream of high-temperature ionized gas (plasma) moving through a magnetic field. Thus, the plasma replaces both the armature and the turbine.

When highly stressed, hot parts are eliminated and a cooled channel is used, very-high-temperature gases can be utilized in the generator. High peak temperature in a thermodynamic cycle is synonomous with high cycle efficiency.

In the experimental Mark II generator, the hot plasma is provided by a combustion chamber, somewhat similar to a rocket thrust chamber. The combustion chamber burns kerosene or alcohol and oxygen "seeded" with powdered potassium salts to make the plasma an electrical conductor. The combustion chamber runs at about two atmospheres pressure, and burns about four pounds of mixture per second. The plasma enters the generator channel at a temperature of about 5000°F.

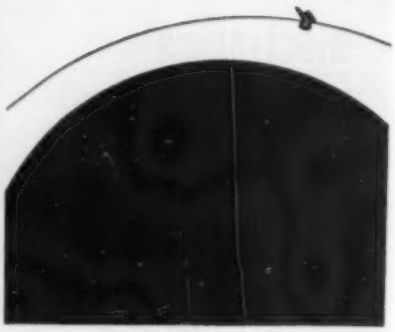
The Mark II is designed for runs of up to one minute, which is more than adequate for studies of fluid mechanics. Long-duration tests of generator components will be conducted on a smaller scale. The information obtained from building and operating this generator will help to determine the answers to many questions about practical MHD power generation: engineering problems connected with large-scale generators; actual vs. theoretical performance; effects of high temperatures on materials.

• **Economics considered**—The economic feasibility of the MHD powerplant has also been studied during the year. AEP says that developments have reinforced earlier conclusions that the MHD system can give greater efficiencies at capital costs competitive with conventional powerplants. They contend that the first MHD powerplants could be as much as 40% more efficient than existing electric powerplants at the outset—and still have a long future of refinement and development ahead.

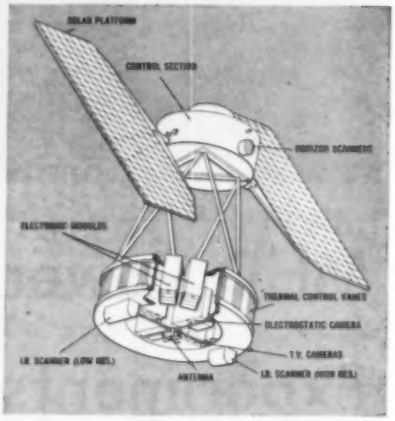
• **Continuing research**—One aim of AEP's continuing research and experimentation program is to determine the most efficient and practical generator system. It appears now that the first working MHD powerplants will be fossil-fueled open-cycle systems, but researchers are hopeful that continued development of nuclear power sources could mean the eventual use of closed-cycle nuclear-fueled MHD systems.

Many other aspects of the MHD generator system are under study, including various methods for converting the direct-current output of the generator to alternating current. At present, simple inverters appear to be the most feasible means of creating a-c, but some consideration is being given to ideas for making the generator produce a-c directly.

In addition, the basic nature of high-temperature plasmas and their interactions with magnetic fields is under continuous study which, it is hoped, will lead to significant improvements in existing concepts and devices. ⌗



PROJECT NIMBUS



Nimbus is the second step in NASA's research and development program to study weather technology. Differing from its predecessor, Tiros, Nimbus will view the Earth at all times.

Orbit—Weighing approximately 650 lbs., Nimbus will circle the earth every 108 minutes in a 600 mile-high polar orbit.

Equipment—As many as 6 TV cameras, plus infrared measuring devices, tape recorders, telemetry and command instruments will be contained in the satellite.

Data Acquisition—Cloud pictures and other information will be played back on command to U.S. meteorologists at Fairbanks, Alaska. Foreign scientists, also, will be invited to participate in the program.

Control and Stabilization—A specially built system will keep TV cameras always oriented toward the earth and permit cameras to view particular sectors of the global cloud pattern.

General Electric's Missile and Space Vehicle Department will provide systems integration for Nimbus, and will develop the control and stabilization system. MSVD is a department of the G.E. Defense Electronics Division. 160-03

GENERAL ELECTRIC

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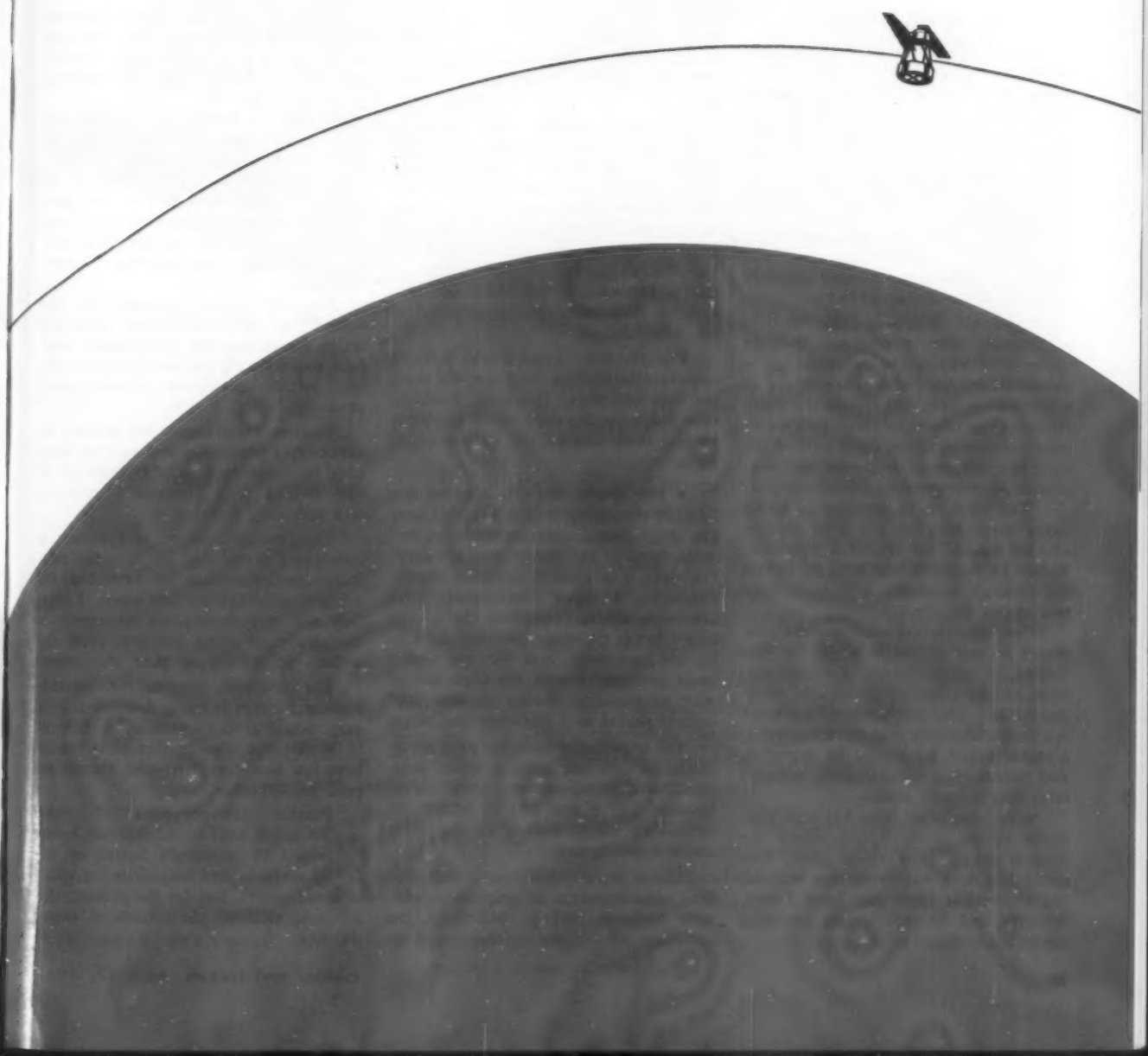
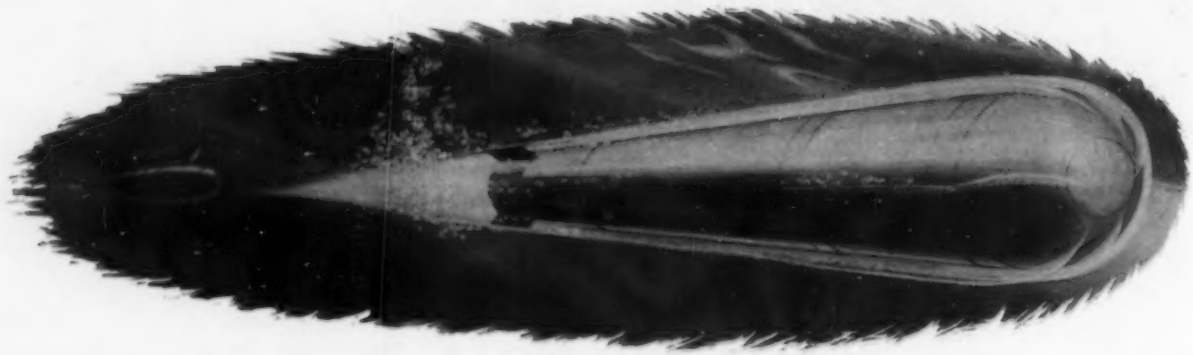
MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

NIMBUS will be America's next-generation weather satellite in space. Continually viewing the globe with TV cameras and other sensors, Nimbus will help man forecast the weather and learn more about its causes. General Electric's Missile and Space Vehicle Department is constructing the space craft and providing systems integration for the system designed by the National Aeronautics and Space Administration.

GENERAL ELECTRIC



Air Wrapping May Speed Torpedoes



by William Beller

SPEED of underwater missiles may be more than doubled through experiments being conducted on vapor boundary layers.

Ever since nuclear submarines first showed their high-speed abilities, the Navy has looked for some way to increase the speed of torpedoes without sacrificing weight and volume for more powerplant. The service fears that future enemy nuclear submarines will be able to outmaneuver—and certainly outspeed—present-day torpedoes.

• **An air wrapping**—One answer may come from a proposal that an underwater missile be wrapped in a sheath of bubbles which would act as a lubricating sheet and reduce the water friction drag almost to zero. This leaves only pressure drag—a small part of the total hydrodynamic drag—for the powerplant to overcome.

"The trick is to produce a stable vapor layer between the solid surface and the liquid," say Walter S. Bradfield, Robert O. Barkdoll and John T. Byrne, the Convair scientists who have been testing out the scheme.

The vapor layers studied were produced in one of three ways: by film boiling, by sublimination of a solid surface, and by a heated chemically reacting surface. The results show that there is a thermodynamic region within which a stable vapor layer may be expected, and where the theoretically reduced total drag actually occurs.

So far, the vapor layer has been kept stable up to only 20 fps, where the friction drag is just about gone. This speed is a long way from that wanted. No theoretical limit has been found, however, and the experiments are being continued with optimism.

The instability that develops comes with the transition from laminar flow to turbulent flow in the liquid boundary layer immediately outside the vapor layer.

To put it another way: When a body moves through a liquid, a certain amount of the liquid is dragged along. This is the liquid boundary layer. When the transition from laminar to turbulent flow occurs in this liquid layer, vortexes develop in the interface between the vapor and the liquid. These vortexes start a mixing process, which develops a froth flow immediately adjacent to the solid surface.

The resulting vapor-liquid mixture increases the friction drag over the laminar flow condition. However, Bradfield says that even this drag would probably be less than that caused by the liquid alone.

• **For spurts only**—It appears that a vapor-producing skin is valuable only for short spurts, now measured in seconds, because the energy that produces the vapor is necessarily potential energy. Producing a vapor continuously does not seem efficient, because the energy might better be used powering the propulsion unit itself. Still, like the rocket assist given to aircraft, the extra energy may be imparted during an especially critical period in a torpedo's trajectory.

The experiment included drag measurements with and without model heating. Water temperatures were varied between 180°F and 193°F, within the subcooling range that gave the most stable vapor layers.

There were other tests, including drag measurements on graphite models with nucleate boiling (bubbling), on unheated teflon (non-wetting), and on subliming dry-ice hemisphere-topped cylinders. It was found that nucleate boiling caused a large drag increase over that measured with the unheated graphite model.

It was also found that the unheated teflon (non-wetting) produced no appreciable friction-drag reduction when compared with a wetting surface. In addition, sublimation of dry ice produced large, unruly, gas-filled cavities—in contrast to subcooled film boiling—and large drags under prolonged forced convection.

The experiments indicate that the bounds on the stable vapor layer are set by the subcooling temperature, surface condition of the body, its velocity, and by the onset of hydrodynamic cavitation.

Further experiments are needed in vapor-layer generation and control, possibly by combining suitable features of film boiling with chemically reacting and subliming surfaces.

The research section at Convair is continuing a study to see how far performance limits can be extended by using a subliming surface alone. Later, they will investigate more intensively a chemically reacting surface such as sodium or lithium or pure aluminum.

For practical reasons the heated-surface concept is being discarded. Not only would a "hot" missile be difficult to handle but also its thin skin would have low heat capacity—and, therefore, poor performance.

Further extrapolations of these studies might lead to submarines being controlled by selectively heated or reacting surfaces and torpedoes traveling at sonic speeds. But for the present, the job is to establish the bounds of vapor stability. ⌗

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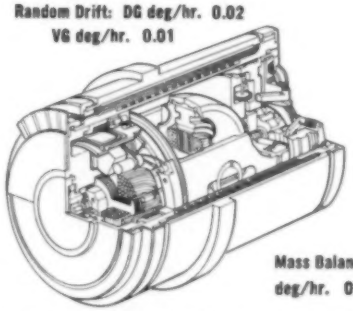

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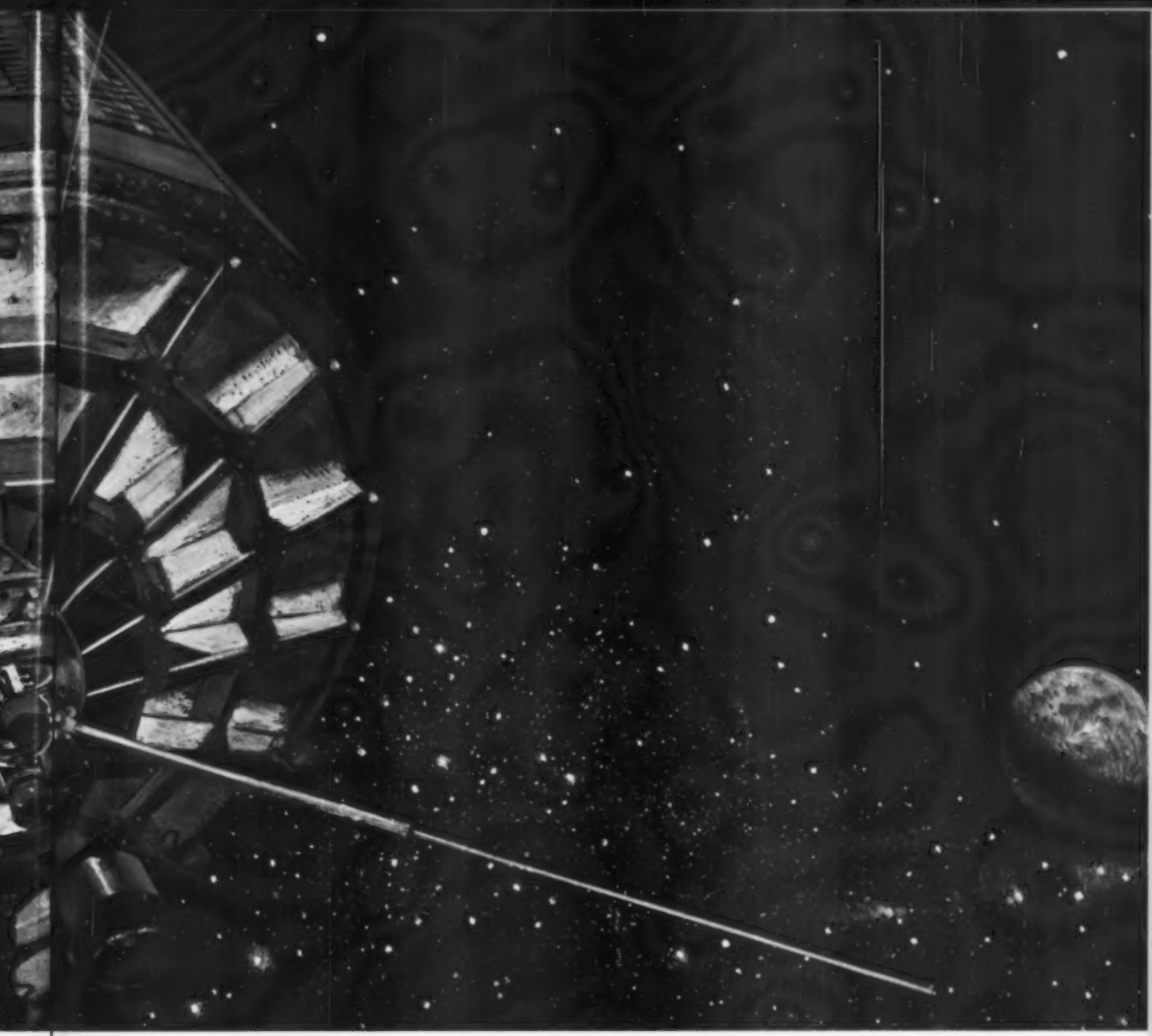

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SFR Knowledge Can Cut Shielding

Douglas scientist explains how 12 years' study shows less protection needed in June, December

by John F. Judge

RADIATION SHIELDING for manned lunar missions can be considerably reduced by applying current knowledge of solar-flare radiation events.

A. D. Goedeke, Chief, Space Physics Group, Douglas Aircraft Co., Inc., told the Annual Meeting of the Institute of Environmental Sciences in Washington, D.C., that this was especially true for missions planned for the months of December and June.

Goedeke said there is a semiannual variation in the occurrence of solar-flare radiation (SFR) events which has a maxima near the equinoxes and minima in June and December—as observed in the Northern Hemisphere.

In addition, there is a direct relationship between sunspot number and the number of SFR events. The frequency of occurrence of SFR events exhibits an 11-year variation which is in phase with the sunspot cycle.

Another associated peculiarity is that the form of monthly distribution of SFR events correlates closely with that of geomagnetic activity and auroral events.

All of these were derived from studies over the past 12 years.

• **Sun storms**—A solar flare, sometimes referred to as a chromospheric flare, is a short-lived sudden increase in Hα (6563, A, red) intensity occurring in the neighborhood of a sunspot. In addition to the bright Balmer lines of hydrogen and the lines of ionized calcium, the flare produces emission lines of HeI, FeII and other metallic elements.

Visual studies have revealed that flares are relatively flat structures extending parallel to the solar surface. The thickness is three to four times the thickness of the chromosphere, with the uppermost portions penetrating into the corona. In time, the flares are essentially stationary in their position.

Solar flares are classified according to their areas on the disk of the sun at maximum brightness. This area is expressed in millionths of the visable hemisphere or in square degrees (1 sq. deg. = 48.5 millionths = 3.13×10^4 km^2).

In square degrees, a Class 1(−) solar flare would be anything less than 2.06 sq. deg. Similarly, a Class 1 is 2.06 to 5.15 sq. deg., a Class 2 is between 5.15 and 12.4, a Class 3 falls into 12.4 to 24.7, and a Class 3 is anything greater than 24.7 sq. deg.

Goedeke pointed out that the occurrence of solar flares is not as rare as some might think. During the International Geophysical Year, a total of 6762 flares were observed. Of these, only 21 were associated with the arrival of solar protons in the earth's vicinity. Goedeke assumes that only major flares of Class 2 or greater are the cause of the observed ionizing radiation increases. Then about 1 out of every 25 results in an SFR event.

• **Periodic manifestations**—The peculiarities in the frequency of occurrence of SFR events are presently difficult to explain, says Goedeke. It has recently been shown that the maxima of the semiannual variation in geomagnetic activity occur at the equinoxes, and that the daily variation can be directly correlated with the daily change in the obliquity of the earth's magnetic axis relative to the earth-sun line, along which the low-energy solar corpuscles are assumed to travel.

Considering the correlation of the monthly distribution of SFR events, geomagnetic activity and auroral events, Goedeke says it is reasonable to assume that the cause of the semiannual variation is the same for all three cases. He advanced five mechanisms to explain the periodicity:

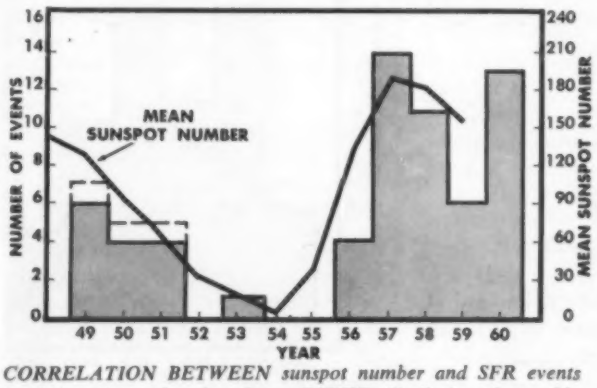
—A consequence of observational techniques;

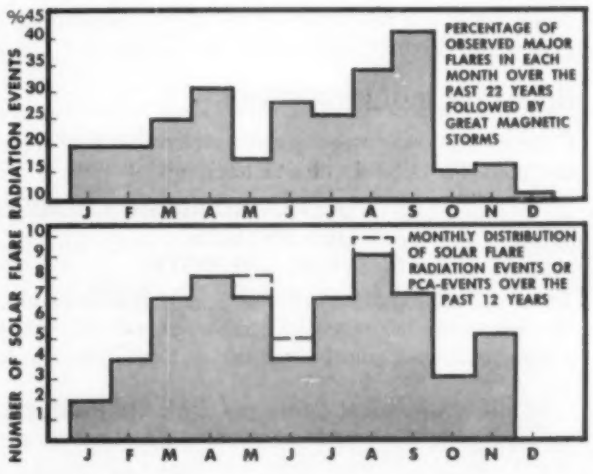
—True solar phenomena;

—Periodic changes in the interplanetary magnetic field (Combination of terrestrial and solar fields);

—The heliographic position of the earth relative to the active sunspot bands; or

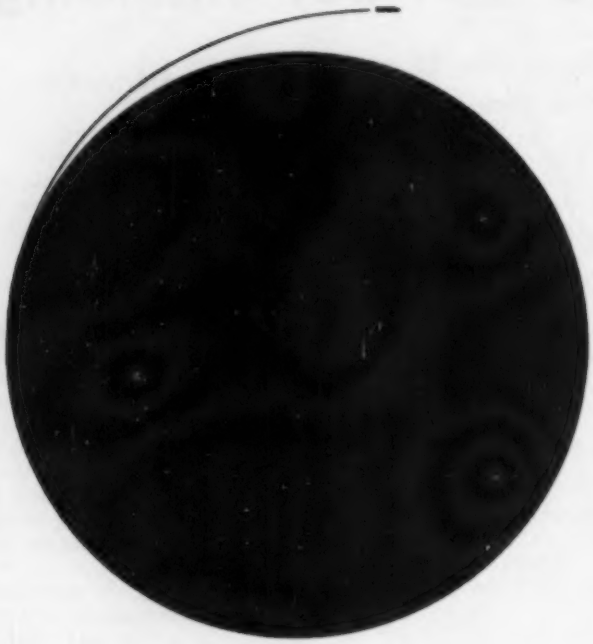
—A combination of two or more




PERCENTAGE OF OBSERVED MAJOR FLARES IN EACH MONTH OVER THE PAST 22 YEARS FOLLOWED BY GREAT MAGNETIC STORMS
MONTHLY DISTRIBUTION OF SOLAR FLARE RADIATION EVENTS OR PCA-EVENTS OVER THE PAST 12 YEARS
NUMBER OF SOLAR FLARE RADIATION EVENTS
J F M A M J J A S O N D

CORRELATION BETWEEN sunspot number and SFR events is obvious from the plot above. RIGHT: Similarity of monthly magnetic storms preceded by major solar flares with the SFR events of the last 12 years is apparent here. PCA (polar cap absorption) events furnish direct evidence for SFR events.

CALLERY PROPELLANT BRIEFS



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of the above four factors.

Goedeke concentrates on the third and fourth possibilities.

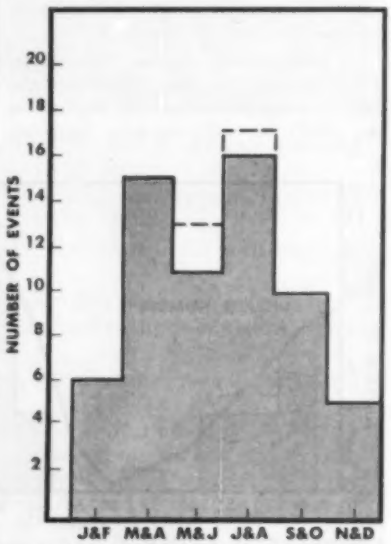
The third mechanism relies on the changes of the interplanetary magnetic field which may be due to changes in both the solar and terrestrial fields. As solar flare protons are thought to travel along magnetic lines of force which emanate from the sun, any combination of the solar and terrestrial fields would have to produce a magnetic barrier, essentially blocking proton passage during June and December.

Since proton energies up to 500 mev are present during SFR events, Goedeke says it is doubtful that such a barrier could have the proper orientation and strength to repel solar protons.

But such a mechanism may be plausible for explaining the variations in auroral events and geomagnetic activity.

The fourth possibility is more attractive, because simple geometry can be used. Practically all of the solar sunspot activity falls within two zones parallel to the equator and within ±45° latitude. The zones have an average width of 15–20° and rarely reach the equator. The first spots of a new cycle occur at about 30° N and S. At activity maximum, the zones reach ±15° latitude, while the last spots in the cycle appear at about ±8°.

The migration of these zones in latitude follows a periodicity of 11.1 ±0.4 years. This is more regular than the sunspot cycle. The facts that active sunspot regions rarely reach the solar equator and that the earth passes through the plane of this equator on June 5 and December 5 appear logically related.



BI-MONTHLY distribution of PCA events between 1949-1960 exhibits the semiannual variation which could be used to avoid heavy shielding in manned flights.

Goedeke says that both theories are attractive—from different points of view. Future space experiments will prove one or the other correct or, quite possibly, both wrong.

The Douglas physicist urges concurrent measurements of low-energy particles and magnetic field variations in the plane of the ecliptic and 30° out of this plane. Such investigations would greatly increase our present understanding of the interplanetary medium and solar magnetic fields.

Several "solar bursts" were included in Goedeke's discussion of the SFR event frequency. These bursts differ from the average solar flare radiation in that the energy spectrum extends into the Bev region and geomagnetic activity is unusually high and world-wide.

From 1942 to date, a total of 7 solar bursts have been observed. Taken separately, little can be said about their frequency of occurrence due to the appearance of only 7 in 19 years. Goedeke points out that no such burst has ever been observed to occur at the maximum of a sunspot cycle. Five events occurred on the descending leg of a cycle and the other two on the ascending leg. This is a tendency of SFR events in general.

Goedeke feels that another complete cycle must be monitored before any conjecture can be made concerning the relation of solar bursts with the sunspot cycle.

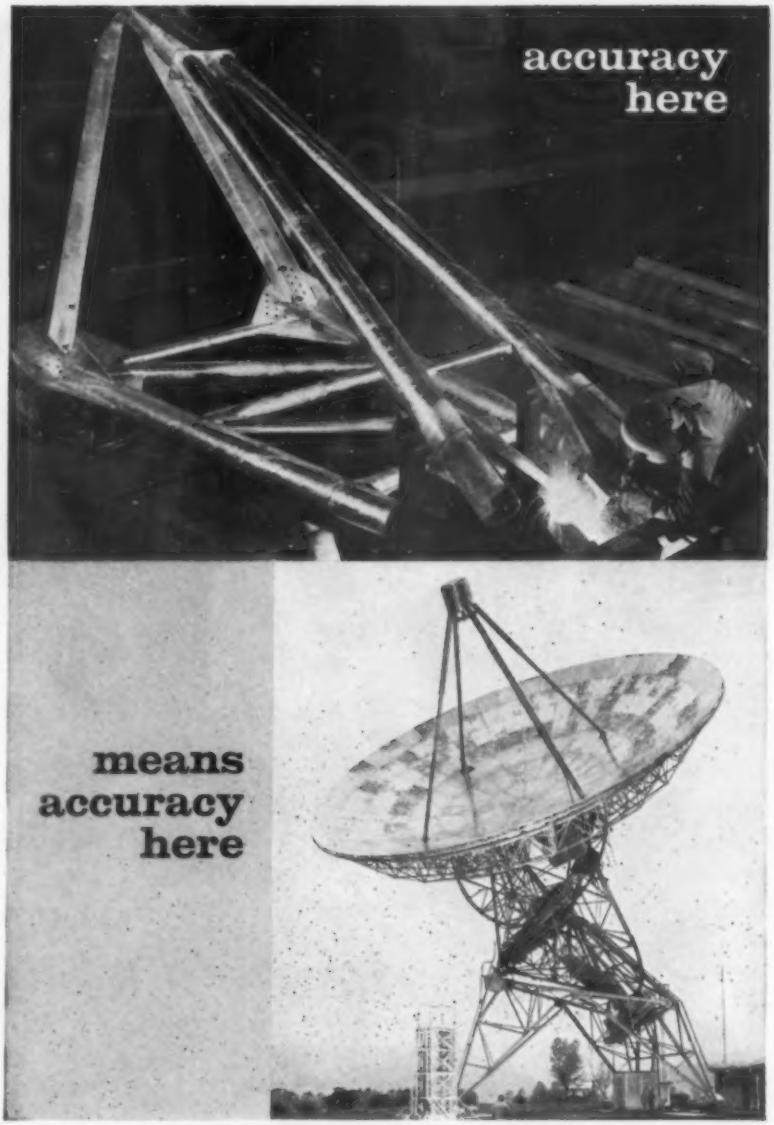
• **Avoidance techniques**—Utilizing the semiannual variation and K. A. Anderson's technique for predicting the occurrence of an event 2–4 days in advance, short-term term missions may not require burdensome shielding.

The prediction technique will not be effective to any large degree except as a warning device with respect to longer-term flights. The annual variation also offers little hope in cutting down shielding demands for Mars-type trips.

But the 11-year cycle of SFR events which follows in phase the sunspot cycle might render shielding a waste of payload capacity during periods of minimum solar activity. For instance, only one small event occurred during the 1952-1955 interval.

This would imply that manned space missions should commence in the 1963-65 interval, which, says Goedeke, may be premature in regard to vehicle ability.

Assuming that the earth-sun geometry in relation to the sunspot bands is the cause of the periodic variations in geomagnetic activity, auroral and SFR events, it may be reasonable to conduct long-term missions within the plane of the solar equator. The possibility of such an avoidance technique may prove fruitful, Goedeke says, but little reliance can now be placed in its use. ⌗



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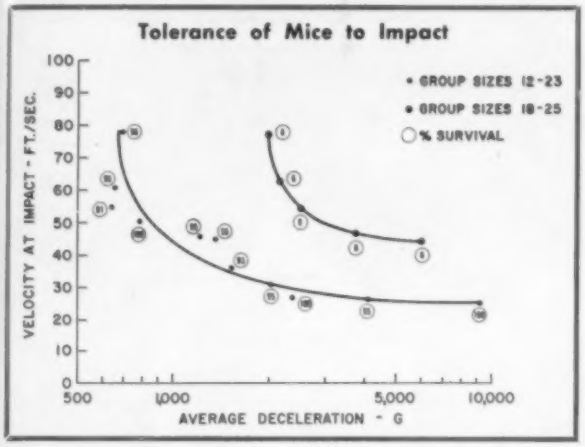
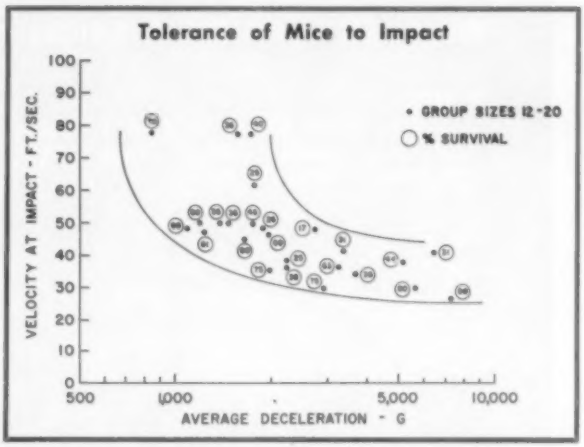
Mice Impacted to Save Astronauts


Tolerance of Mice to Impact
VELOCITY AT IMPACT - FT./SEC.
AVERAGE DECELERATION - G
• GROUP SIZES 12-23
• GROUP SIZES 18-25
○ % SURVIVAL

SURVIVAL RATES of "dropped" mice in two separate groups indicate that small, restrained animals can tolerate impact velocity of about 19 mph and deceleration of 650 g's, up to about 31 mph impact velocity and 1970 g's. (Graphs by GE.)



by Heather M. David

MOST STARTLING of all laboratory research programs on the effects of spaceflight probably is being conducted at General Electric's Missiles and Space Vehicles Department in Philadelphia.

Visitors to the multi-storied Chestnut Street building are apt to be startled by the sight of a group of white-coated technicians on their knees peering into the depths of an elevator shaft. But they aren't examining the fate of some hapless colleague, as one might fear, but carrying on highly calculated, objective research.

Subjects of the experiment are some 700 white mice who are giving their all to help plot the chances of survival for astronauts impacting on the earth's surface after spaceflight.

The tiny subjects—all weighing between 11 and 21 grams—are encased in snugly fitted plastic tubes, loaded on a carriage at the top of the elevator shaft and dropped some 100 feet to the bottom.

The carriage is guided in its fall by a cable strung vertically from the top of the drop shaft to a lead-covered anvil on which it impacts. The mice are positioned so that they receive the impact on their backs.

• **Impact tolerance limits**—The Life Support Operations group came up with these results after testing 744 mice: All the mice could survive an impact velocity of 27 feet/second (19 mph) and deceleration of 650 g's. None of the mice could survive impact velocity of 45 feet/second (31 mph and 1970 g's. The charts show the percentages of mice which survived within these limits.

Some experimental work showed that for magnitudes below these values, tolerance could be expected. Animals survived impact velocity of 78 feet/second (55 mph) for deceleration less than 650 g's and 9300 g's for velocities less than 27 feet/second.

According to project leader Dr. Armand Gold, almost all the mice respond in "an all-or-none manner." That is, they die within 30 seconds or live to survive indefinitely.

Gold's group controls the magnitude of inertial loads and rates of onset by inserting compressible lead stopping devices of different shapes and thicknesses on the anvil. They calculated average deceleration from the standard formula

$$G = \frac{V^2}{2S \times 32.2}.$$

G is the applied decelerative force in multiples of the force of gravity, V is velocity (feet/second) at impact, S is stopping distance (feet) and 32.2 is the constant representing deceleration due to gravity (feet/second^2).

Post-mortem examinations seem to indicate that death in the restrained mice resulted from sudden displacement of the central nervous system, particularly of the brain. The tests apparently bore out the fact that animals receiving high g forces in the transverse position —from back to chest—survive with the fewest injuries.

Although there has been evidence of some hemorrhaging in the lungs, spleen and surface of the cerebrum of the mice which were killed by fall, the extent was not considered to be fatal. Dr. Gold also said that the hyperbolic shape of the tolerance curve indicated that there was only a single factor causing death.

The brief duration of impact in the experiments (up to several milliseconds) has led the GE group to conclude that tissues may respond in a way similar to that of inert materials under mechanical stress. Injuries (for durations up to 0.2 seconds) are believed to be dependent on physical properties such as elasticity, viscosity, frequency response, tensile and shearing strength and compressibility of tissues.

• **What about humans?**—The General Electric group generally feels that humans can be expected to react in much the same way as smaller animals, provided the restraint system system is adequately designed.

A human tolerance curve constructed from crash, accidental fall and rocket sled data asymptotes at approximately 80 feet/second (56 mph) and 22 g's. Murray Kornhauser, a member of the GE Life Support Operations group, constructed this theoretical sensitivity curve.

The data gathered in the tests will eventually be incorporated in the design of restraint and escape systems for MSVD projects. ■

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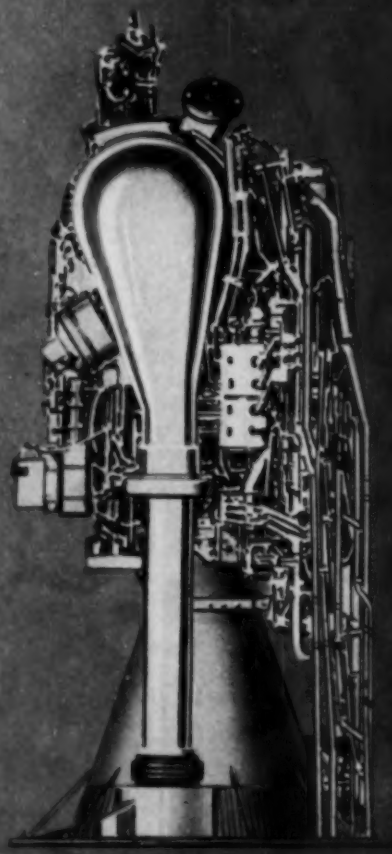

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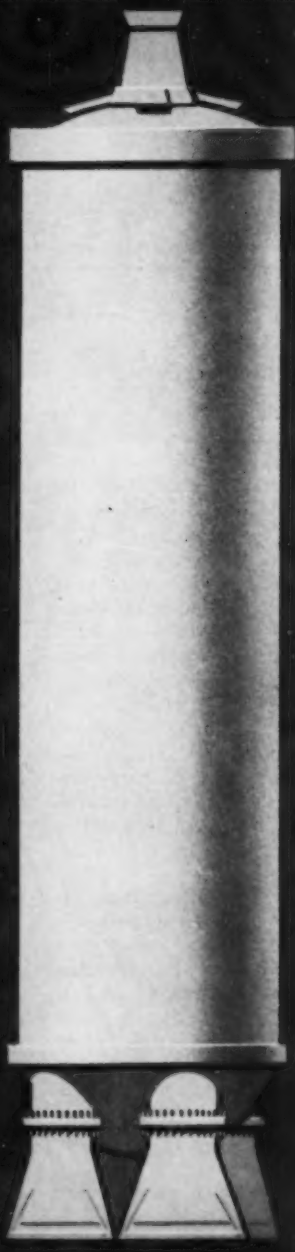

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FOLLOW-THROUGH CAN DELIVER
S for SPACE FLIGHT

RELIABILITY IN NUCLEAR PROPULSION

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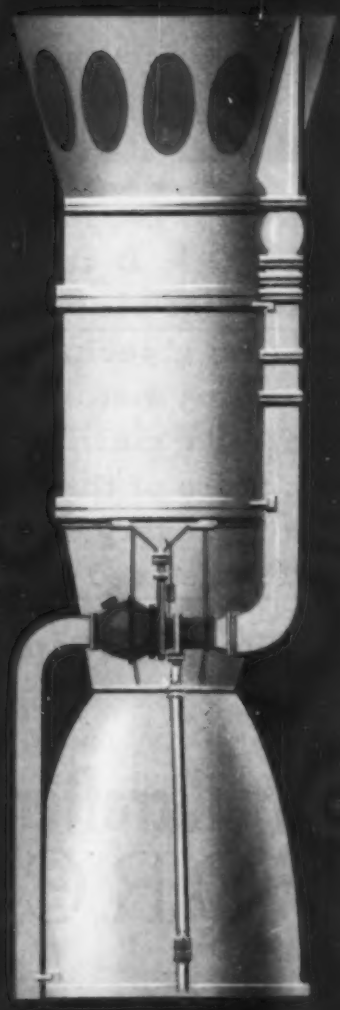

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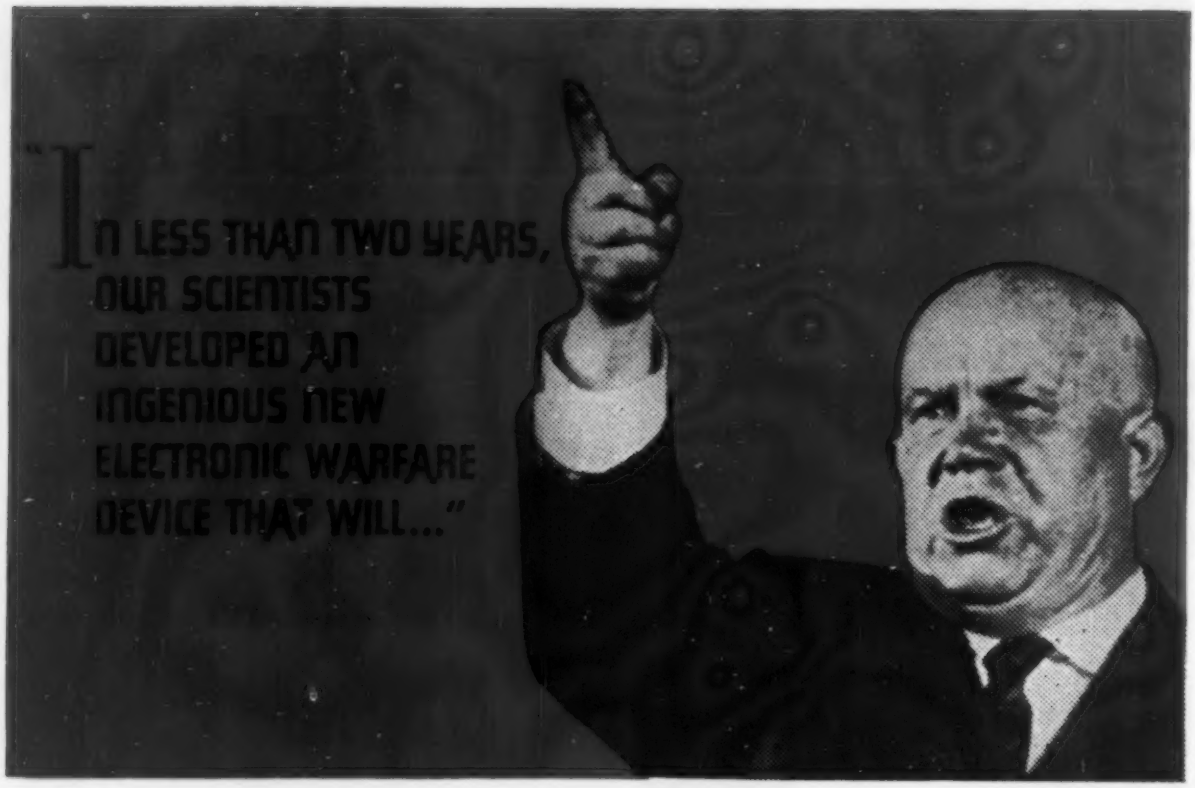

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Russian Shots show single purpose

(Continued from page 16)

The three "Cosmic ship" launchings of last summer and fall probably ironed out all of the major bugs—at the very least, they more than proved the feasibility of the approach. A certain degree of confidence resulted from these shots—as evidenced by the fact that Gagarin's flight was announced while still in progress.

• **More than boosters**—The Russian capabilities in boosters are well known. Each of these space cabins weighed in the neighborhood of 10,000 lbs. About five times the weight of the *Mercury* capsule and twice that of *Dyna-Soar*. Here there may be some clues as to how the Russians approach the re-entry aspect of manned flight as well as life support and communications.

But the sheer size of the boosters is simply another outcome of a well-planned, integrated program. In the years since *Sputnik I*, the Russians sent three probes toward the moon, one of which went into a solar orbit. In February, the Venus probe was launched.

It seems at first glance that these are separate from the train of events culminating in Gagarin's flight. But if the single-minded Russian approach to space involved man from the very start, then these may well be included.

It is true that U.S. satellites are more numerous and have supplied an enormous amount of information. But the Russians may well have gathered only that data they deemed absolutely necessary as their man-in-space program developed.

Taking this narrow viewpoint, the *Luniks* and the Venus probe could indicate the emergence of a broadened manned space effort—one in which the Gagarin flight constitutes but a single element.

If this is the case, it means that the Russians are actively pursuing immediate goals far beyond the orbiting of one man around the earth. The world's reaction to Gagarin's flight contains ample evidence that the feat was not unexpected. But precisely when did the directors of the Soviet space effort adopt this view? And how high did they then raise their sights?

Perhaps the three *Luniks* had nothing to do with manned flight. And maybe the Venus probe was an "art for art's sake" affair. ⌗

The Soviet Pattern!

Soviet Designation	Launch Date	Total Weight in Orbit (lbs.)	Remarks
Sputnik I	10-4-57	8,616	184 lb. payload—Earth's first artificial satellite.
Sputnik II	**11-3-57**	**11,000**	**1,120 lb. payload—Biomedical satellite.**
Sputnik III	5-15-58	10,275	2,925 lb. payload—Physical data satellite.
Cosmic Rocket I	1-2-59	796	Lunik I (Mechta), Solar Orbit, passed within 4,000 mi. of moon.
Cosmic Rocket II	9-12-59	860	Lunik II, impacted on moon Sept. 13, 1959, after approximately 35 hours flight time.
Automatic Interplanetary Station I	10-4-59	614	Lunik III, photographed far side of moon, Lunar Magnetic Data, Micrometeorites.
Cosmic Ship I	**5-15-60**	**10,009**	**Sputnik IV—Near circular orbit of pressurized cabin, life support checkout. Failed to re-enter properly.**
Cosmic Ship II	**8-19-60**	**10,143**	**Sputnik V—Space Cabin and life support system containing 2 dogs, and an assortment of rats, mice, flies, etc. Recovered successfully Aug. 20, 1960.**
Cosmic Ship III	**12-1-60**	**10,614**	**Sputnik VI—Space Cabin and life support system containing 2 dogs. Failed to re-enter properly.**
Sputnik IV	2-4-61	14,295	Sputnik VII—No details announced by USSR but possible attempt at Venus.
Automatic Interplanetary Station II	2-12-61	1,419	Venus Probe—Radio contact lost Feb. 27, 1961, but may have been restored.
Cosmic Ship IV	**4-12-61**	**10,460**	**Sputnik VII—Space Cabin and life support system containing one man. Recovered successfully after one earth orbit April 12, 1961.**

Soviet Spaceman

(Continued from page 15)

"space platform or even a base on the moon."

In the House, Chairman Overton Brooks (D-La.) of the House Space Committee said NASA's budget should be increased nearly another half-billion dollars. Rep. Victor Anfuso (D-N.Y.), a Space Committee member, said the NASA 10-year space program should be accomplished in five years.

Members of both the House and Senate said the Soviet space flight can be expected to have an immediate impact on East-West affairs in trouble spots from Latin America to Asia. Informed government officials said the United States could expect Russia to use the space flight as a psychological weapon in swinging African and Asian leaders into the Communist Bloc.

Even as the wave of dismay swept through parts of official Washington, Moscow was preparing to receive Comrade Gagarin in triumph and Soviet Premier Khrushchev was boasting of the eventual triumph of Soviet Communism over the West.

The Soviet victories that had begun on Oct. 4, 1957 with the launching of Sputnik I had culminated despite the disparaging comments from American leaders with Gagarin's flight of April 12, 1961.

Now, the Soviets forecast they would reach out for the moon ahead of the United States. Who was confident that they would be proved wrong? ⌗

Messages From Space

Spaceman Yuri Gagarin, in a series of four messages radioed from space, apparently found his 108 min. flight around the globe rather enjoyable. But the messages shed little light on conditions in space.

"I can see the earth," he told Soviet scientists on the ground. "Visibility is good. I can hear you excellently."

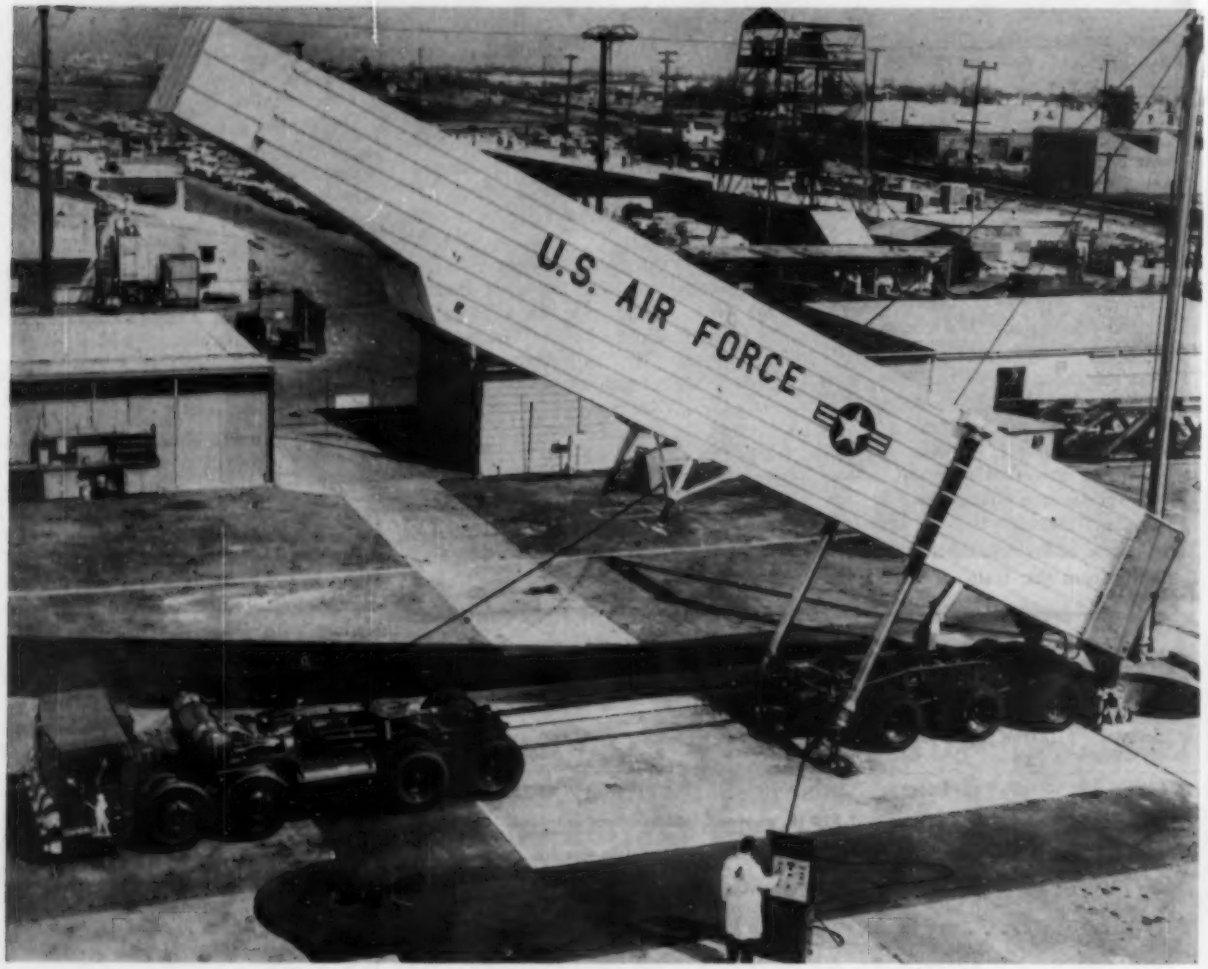
"The flight goes well," he said in another message. "I can see the earth. I can see everything. Some of the space is covered with clouds."

Interference made it hard to hear Gagarin.

His third message said: "I continue the flight normally. Everything works excellently. I am going farther."

"I feel fine," the fourth message said. "My spirits are high. I continue the flight. All goes on well. The machine works normally."

Minuteman's Big Emplacement System



MINUTEMAN HOUSED IN 63-ft.-long truck container is raised to vertical in first public demonstration at Bendix-Pacific.

NORTH HOLLYWOOD, CALIF.—Getting the first operational *Minuteman* into place at its silo will take between four and six hours—but this time will be sharply reduced with experience.

Bendix-Pacific, responsible for emplacement equipment for the Air Force ICBM, says it will need about two hours to carry out its share of the emplacement job when the solid-fueled bird becomes operational in mid-1962. The remaining time will be required for miscellaneous operations by Boeing Airplane Co. personnel.

Bendix-Pacific has delivered four complete emplacement systems to Boeing, assembly and test contractor for *Minuteman*, and has just received a contract for five additional systems. The follow-on contract is for slightly less than $1 million, and calls for delivery of the first unit this fall.

Weighing 108,000 lbs. gross, the transporter-erector equipment consists of a General Motors tractor and rear carriage, a Cessna missile container, and the Bendix emplacement system.

• **Emplacement**—Four principal subsystems make up the emplacement system: A major hydraulic power supply, two erector actuators, a hydraulic-powered mechanical hoist, and an electrical control panel to sequence all steps in the operation.

The main hydraulic power supply is driven by the tractor engine and develops 20 horsepower at 10 gallons per minute and 3000 psi. The system has a 150-gallon reservoir including a temperature control switch preventing the power supply from operating if the fluid is not the correct temperature. The unit has a dual-pump feature to ensure reliability.

The dual erector actuators consist of three telescoping sections, each extending 35 feet and capable of lifting 108,000 lbs. With a wall thickness of about ⅜-in., the tubes lift the container from horizontal to vertical in about 12 minutes.

The hydraulic-powered mechanical hoist, produced for Bendix by Western

(Continued on page 44)

...key to life

Water means power . . . water means raw materials . . . water means the life of the maritime nations. Still—man is ignorant of the mysteries of the oceans . . . he is only beginning to search the depths.

General Motors Defense Systems Division is vitally interested in all ocean phenomena. For example, new nuclear submarines and their cargoes of ballistic missiles constitute one of America's most effective deterrents against attack. Water—and the *control* of water—is vital to national defense.

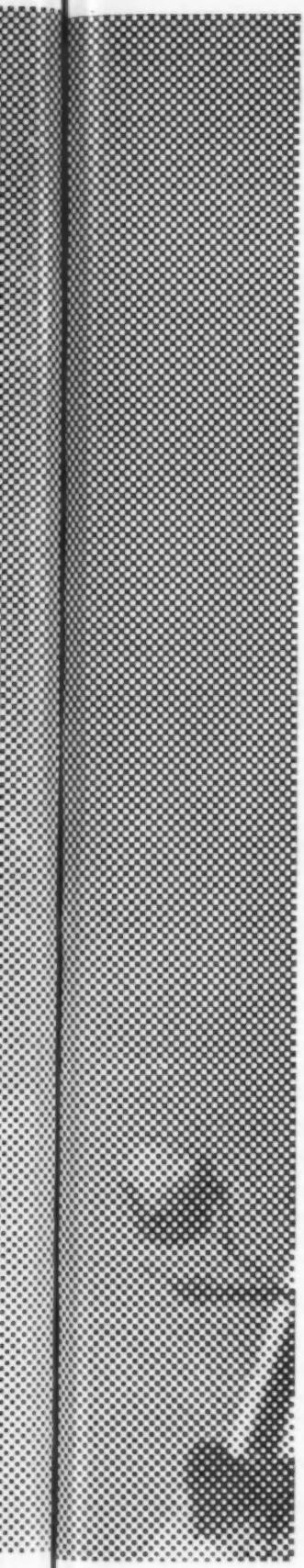
Scientists and engineers in the laboratories of the Defense Systems Division are also hard at work in land, aero-space, astrophysics, biological sciences, oceanography, nucleonics, and basic research projects.

DSD is dedicated to serving the Defense Department and other government agencies, in cooperation with many different branches of industry and scientific groups, in fields of fundamental research and engineering through the coordination of knowledge, abilities, ideas and hard work.

General Motors is proud to contribute, through the growing Defense Systems Division, to the strength of America and human progress. Top-level scientists and engineers in all of these specialized fields will find rare opportunities and challenging assignments in this fast-growing organization.

DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION, WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

Computer-listed master catalog of engine parts reduces production lead time at Rocketdyne.



Keeping the cost of space down to earth

Behind the thundering performance of Rocketdyne's engines, a significant reduction in the cost of power for America's missiles has been quietly achieved. Today, Rocketdyne engineering skill and efficient production methods make it possible to power two missiles for the cost of one in 1957.

Rocketdyne, the pioneer in rocket science, was first with power for America's long range ballistic missiles—first with power for outer space. In establishing this technological leadership, Rocketdyne developed new management concepts at every level of operation, from early design through final testing. The result is outstanding technical achievement at the lowest possible cost.

In data processing alone, advanced techniques are saving engineers hundreds of hours of experimentation and testing and have contributed to a 37 percent reduction in Atlas engine costs for the Air Force. An intracompany communications network links test stands and research laboratories in Missouri, Texas and California; gives management the daily status of every program—whether it's on schedule, what parts are in short supply, how the production line is performing.

Through research, engineering, and management, Rocketdyne is constantly at work not only to increase thrust performance and develop new propulsion techniques, but at the same time to reduce costs all along the line.

34 of America's 38 successful satellites and space probes have been launched by Rocketdyne engines.

FIRST WITH POWER FOR OUTER SPACE

ROCKETDYNE

DIVISION OF NORTH AMERICAN AVIATION

Canoga Park, California; Neosho, Missouri; McGregor, Texas

(Continued from page 40)

Gear Corp., can lift 100,000 lbs., or 50 times its own weight. The entire hoist assembly weighs approximately 2000 lbs. *Minuteman* is hoisted by 48 strands of ¼-in. cable, which also handles all the equipment attached to the missile.

Minuteman is officially listed as being in the 60,000 to 70,000 lb. weight class.

The electrical control panel sequences and controls the 67 steps in the operation, including 11 classed as "critical." Major phases include raising the container from horizontal to vertical (12 minutes), traversing the missile within its container to separate it from its handling dollies (7 minutes), lowering the missile to the launch ring in the silo (35 minutes), and return of the container to horizontal on the transport carriage.

Traversing the missile away from the floor of the container moves it away from all equipment used while the transporter and missile are horizontal. This operation shifts the top of the vehicle 13 inches and the bottom, or first stage skirt, four inches. The missile is then clear of all obstructions when it is lowered through the container. The dollies are secured to rails in the container.

• **Safeguards**—Safety factors in the control panel prevent the operator from advancing to the next critical step until the previous step is completed. Eleven such critical steps are in the series of 67. Additionally, if the operation is begun and a failure occurs in part of the system, the equipment must be capable of either lowering the missile into the silo through a manual override capability or returning it to the container. The Air Force insists that the temperature-sensitive *Minuteman* not be exposed to an uncontrolled environment for excessive periods.

Minimum life span of the transporter-erector unit is 500 emplacement cycles, and Bendix has set up tests to 750 cycles to prove dependability. Governing factor is apparently the hydraulic seals and similar components. A refitting program would put a unit back in operation.

The base plate used to support the missile during lowering is left in the silo and the vehicle is subsequently launched from it.

Accuracy of the emplacement is not a critical factor, since a rotatable ring supporting the missile in the silo is used later to orient the guidance system precisely. The Bendix emplacement system puts the vehicle within two degrees of rotational angle; then adjustments are carried out. Vertical alinement is also adjusted after emplacement is completed.

The Cessna-built container maintains a controlled environment for the missile by automatic controls and lightweight thermal insulation. Made of magnesium and aluminum, it weighs 8500 lbs. empty, is 8 ft. wide, 8 ft. high and 63½ ft. long. In transit, its top is 13 ft. above the highway.

General Motors' tractor and carriage use a V-12, 275-hp gasoline engine and a five-speed main transmission with three-speed auxiliary transmission. Road clearance is 9 in.; overall tractor height is 6 ft.

The test silo used by Bendix-Pacific is smaller than the operational silo, being 9 ft. across and 65 ft. deep. The operational version is 12 ft. wide and 85 ft. deep. A 75,000-lb surplus test vehicle from the Edwards AFB firings that proved out silo configuration is used to check out the emplacement system.

The guidance system for the missile is transported in place, so that no extensive checkout equipment will be necessary at the silo to re-test it after the thorough factory tests are completed. AF spokesmen estimate that shock on the missile during transit is about ⅓ g —far less than the shock of launching.

Only basic checkout equipment will be used at the silo, to ensure that no disruption in circuitry has been caused by transportation. The missile is slated to be carried from the assembly plant at Hill AFB directly to the silo for emplacement.

• **Simple transport**—Highways are expected to present no problems to the transportation of *Minuteman*, since a thorough survey was conducted on all roads expected to be used in potential site locations. The maximum gross weight of the transportation system—108,000 lbs.—was consciously designed to get under the strictest highway maximum-weight regulations in the country.

By some roundabout routing, the Air Force says, it can get *Minuteman* to its silos with no more than strengthening of a few culverts. No bridges will have to be moved or other similar steps taken.

Highway safety has been assured by deliberately trying to ignite the propellant through every possible accidental means. The Air Force has fired rifles into the solid-propellant rockets, put blazing gasoline containers under them, and even fired a shaped explosive charge into the missile to try ignition susceptibility. The shaped charge merely ruptured the case and made a crater in the propellant. No accidental ignition was experienced.

The Air Force adds that the transporter system is designed so that there is no danger of capsizing.

Unrefueled range of the tractor is 250 miles. The unit is designed to climb a grade of 17%. ⌗

Ajax Radar Simulators To be Changed for Hercules

RADAR SIMULATORS (15D2's) built for training *Nike-Ajax* radar operators will be modified for *Nike-Hercules*.

A bidders conference was held recently at the Army Rocket and Guided Missile Agency, Redstone Arsenal, Ala., to brief contractors on the new requirements.

Shortly thereafter, the Pentagon quickly spiked rumors circulating in Washington that the "updating" was cover-up for the fact that none of the *Ajax* simulators had ever performed as designed.

The trainers were built originally by ITT Federal Division from a prototype built by Aircraft Armament, Inc. Ninety-six van-type units were built at a cost of about $10.5 million, according to an Army spokesman.

Original procurement was handled by Naval Training Devices Center, Port Washington, N.Y. for Continental Army Command at Fort Monroe, Va. ARGMA is now responsible for support and production procurement for the *Nike* installations.

The modified system, to be known as AN/MPQ-36, will be improved to handle more advanced target problems than confronted the older short-range *Ajax*. Details of requirements have not been released but two in particular are known: the need for simulating targets employing sophisticated electronic countermeasures and supersonic attack vehicles—missiles or aircraft.

Two of the old 15D2's have been modified, Army said, and subsequent tests have proven feasibility for the new *Hercules* mission.

It is reported that the total numbers of systems to be modified will depend on the cost per unit proposed by the winning contractor. ⌗

Smoke Signals Aid Army Missile Tests

ARMY TEST engineers are using mid-air puffs of smoke to determine effects of vertical winds on missiles.

The smoke puff is created by firing aloft a small container of smoke-producing agent timed to burst at a given height along the test missile's flight path. By studying movie films of the test, engineers can compare the performance of the missile against the visible record of the air currents acting on the smoke.

The technique provides precise wind measurements at altitudes up to 1900 feet. It is being used in missile firing tests at Redstone Arsenal and White Sands Missile Range. ⌗

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Circle No. 18 on Subscriber Service Card

Complete SNAP 2 Unit Due for Early Ground Test

A GROUND TEST of the complete *SNAP 2* power supply, designed to supply up to 3 kilowatts for spacecraft needs, will take place later this spring.

A 200-lb. reactor designed as a prototype for *SNAP 2* by Atomics International Division, North American Aviation, went critical on April 4. The reactor, designated S2DS, will be mated with a power conversion unit composed of a liquid sodium-potassium heat exchanger and a mercury-boiling turbine.

After completion of the test program, a system with flight configuration will be ground-tested in a satellite nose cone, the Atomic Energy Commission reported.

The S2DS reactor is the second built for the *SNAP 2* program and the first designed to be tested with a conversion unit, components of which are being developed by Thompson Ramo Wooldridge. ⌗

EIA Blasts Section Of Small Business Bill

ADMINISTRATIVE cooperation between the Small Business Administration and defense procurement agencies will do more for small business than legislative action, the Electronics Industries Association contends.

Objecting to parts of the pending Proxmire bill (S 836), C. J. Harrison, chairman of the EIA Small Business Committee, said that the proposed legislation is not "an effective approach" in increasing small business participation in government subcontracting.

Principal point of contention is section 8 of the Proxmire measure. If this becomes law, Harrison said, the SBA would become an additional statutory contracting party, resulting in delays in the award of prime contracts and in the selection of subcontractors. It would, he added, "further complicate an already cumbersome and slow procurement process." ⌗

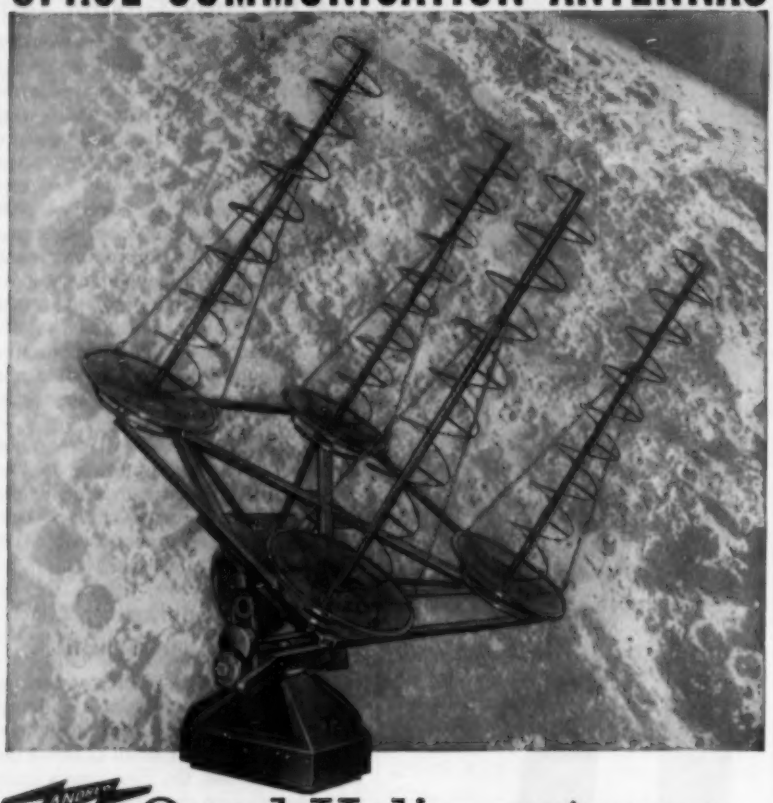
Fairchild Semiconductor Expands Marketing Set-up

MAJOR EXPANSION of Fairchild Semiconductor Corp.'s marketing department advanced regional sales managers in Los Angeles, Chicago and New York to new positions at the Mountain View, Calif., headquarters.

Robert F. Graham became special product-micrologic sales manager, John F. Ready took over diode sales, and Robert W. Dugan was promoted to head transistor sales.

Replacing them were district sales managers Alan J. Bayley, Robert L. Major, and James P. Paris. ⌗

SPACE COMMUNICATION ANTENNAS



ANDREW

Quad-Helix antenna

tracks long and medium-range missiles

Telemetry circuits between missile (or satellite) and ground station are reliably maintained with the ANDREW Quad-Helix Array. This system offers low VSWR, high gain, and easy control.

Gain is 17.5 db at 265 mc, 14.5 db at 215 mc. VSWR is less than 2.0:1 across this range. Polarization is right hand circular; impedance 50 ohms. Counterbalanced rotator provides 180° elevation and 720° azimuth tracking at speeds from 0° to 30° per second.

Optional remote control unit regulates speed and direction.

OTHER ANDREW GROUND-AIR ANTENNAS

TRI-HELIX ANTENNA

880-990 MC 17.5 DB GAIN TYPE 81068

HELIX ANTENNAS

FREQUENCY	GAIN	TYPE NUMBER
108-132 mc	12 db	H 19110 A-1
215-265 mc	10.5 db	H 50140 A
215-265 mc	13 db	H 19110 A-2
260-320 mc	13 db	H 19110 A-3
320-400 mc	13 db	H 19110 A-4
400-500 mc	12 db	H 19110 A-5

DISCONE ANTENNAS

FREQUENCY	TYPE NUMBER
25-50 mc	50154
50-108 mc	51150
108-215 mc	19050-1
215-420 mc	19050-2
420-1000 mc	19050-3

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—names in the news

FIRESTONE

ECONOMOU

George A. Economou: Appointed manager, optical instrumentation, J. W. Fecker Division of American Optical Co., Pittsburgh. Prior to joining Fecker, Economou was senior staff engineer at the Perkin-Elmer Corp.

Edward F. Nauman: Named general manager of Wasatch Division of Thiokol Chemical Corp., Ogden, Utah. Other Division appointments are: **John Higginson,** manager of finance and administration; **Jack Buchanan,** manager of research and development; and **L. C. Taylor,** manager of contracts and customer services.

Louis L. Reasor and **Edward A. Hayes:** Appointed manager and assistant manager, respectively, of Hughes Aircraft Company's Tucson Division.

Dr. T. Keith Glennan: President of Case Institute of Technology, rejoins the board of Clevite Corp. Dr. Glennan was a Clevite director for five years prior to his appointment as first administrator of NASA in 1958.

Neil E. Firestone: Appointed general manager of General Electric's Flight Propulsion Division, Evendale, Ohio. Former general manager of the large jet engine department, Firestone has been with GE since 1942.

Abel DeHaan, Jr.: Elected vice president of Tracerlab, Waltham, Mass. To continue as general manager of the company's Reactor Monitoring Center, Richmond, Calif. Prior to joining Tracerlab, he was a radiochemist at Oak Ridge National Laboratories.

Robert B. Craven: Former staff engineer of the Massachusetts Institute of Technology Instrumentation Laboratory, appointed group leader, instrumentation, at Aerospace Research, Inc., Cambridge.

Martin J. Ruthford; Named director of military marketing for Capehart Corporation's Military and Industrial Division, Richmond Hill, N.Y. Previously, Ruthford was a partner in Senior Associates, Monmouth, N.J.

John H. Vye: Appointed assistant general manager of Remington Rand Univac Military Department, St. Paul. **Lawrence W. Reid** succeeds Vye as director of manu-

VYE

FROMM

facturing. **Richard L. Gehring,** former supervisor of data systems, named manager of field maintenance and training.

William J. Hilty: Appointed exposition manager in communications department of American Society for Metals. **A. P. Ford** named director of communications, and **Fred Stanley** advertising manager for ASM periodical publications.

J. Ward Wright and **R. L. Tibbs:** Named assistant manager and staff representative for electronic requirements, respectively, at The Martin Company's Huntsville, Ala. office.

Winfield E. Fromm: Former head of Space Technology and Research Department, Airborne Instruments Laboratory of Cutler-Hammer, Inc., appointed director of AIL's Research and Systems Engineering Division. Fromm succeeds **Eugene G. Fubini,** recently appointed director of research, Department of Defense, Research and Engineering.

Conrad Kunze: Joins Otis Elevator Company's Defense and Industrial Division, Brooklyn, as assistant general manager. Kunze has held various executive positions for the past 20 years with Convair/General Dynamics in Fort Worth and San Diego, and with Northrop Corporation, Hawthorne, Calif.

David C. Trott, Jr.: Named employment manager of Guided Missiles Range Division, Pan American World Airways, Patrick AFB, Fla.

Peter N. Lensi: Joins Hummel Chemical Co., New York, as research director. Formerly Lensi was with Reaction Motors Division of Thiokol Chemical Corp., Denville, N.J., and research chemist at Picatinny Arsenal.

Herbert Rosenberg: Named manager of digital circuits department of Marshall Laboratories, San Marino, Calif. Previously at Space Technology Laboratories, he was responsible for the design and construction of space instruments aboard *Explorer VI, Atlas/Able-4* and *-5,* and *Pioneer V* payloads.

William I. Moore: Named sales engineer for The Beryllium Corp., Reading, Pa.

. . . Every component in the U.S. Navy's TARTAR, newest supersonic surface-to-air guided missile must meet the highest standards for statistical reliability.
No exception is the Bristol Syncroverter* chopper used in the TARTAR's guidance system. The TARTAR, produced for the Bureau of Naval Weapons by Convair (Pomona) Division of General Dynamics Corporation, is slated to form the primary antiaircraft weapon aboard destroyers and secondary antiaircraft batteries aboard cruisers.
The Bristol Syncroverter chopper has a long history as a component in U.S. guided missiles. It's the ideal miniature electromechanical chopper for use in d-c analog computers or wherever utmost reliability is required.
BILLIONS OF OPERATIONS have been completed without a failure on Bristol's continuing life tests—aimed at improving the Syncroverter's already superlative characteristics. Just one sample: A group of five choppers, with 400 cps drive and 12v, 1 ma resistive contact load have been going for more than 26,000 hours without failure. That's more than 2.96 years continuous operation or more than 37 billion complete cycles!
No matter what your chopper requirements, we're sure you can find the model you need among the wide selection of Syncroverter choppers and high-speed relays available . . . including low-noise, external coil types. For complete data, write: The Bristol Company, Aircraft Equipment Division, 150 Bristol Road, Waterbury 20, Conn.
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*T.M. Reg. U.S. Pat. Off.
actual size
BRISTOL chopper helps put Navy TARTAR on target
BRISTOL FINE PRECISION INSTRUMENTS FOR OVER SEVENTY YEARS

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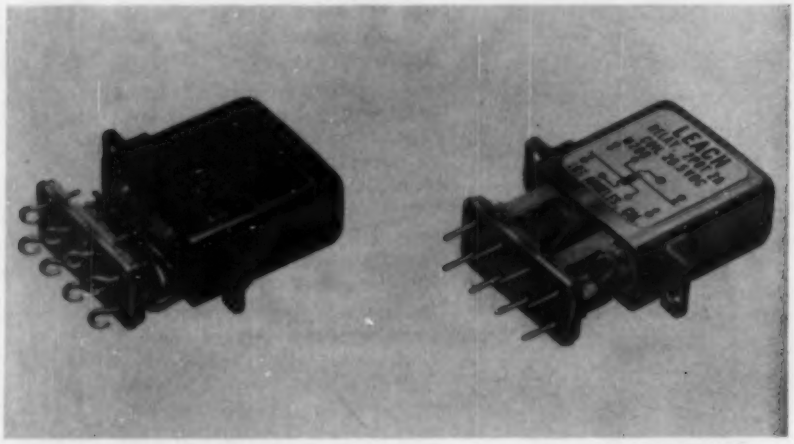


Microminiature Relays

Two microminiature relays—one a half-ounce, high-accuracy solid-state time delay, and the other an MS-approved high-performance rotary crystal can—are available from the Leach Corp.

Where time delays with multiple-output contacts are required, the two can be used in conjunction to perform the work of a much larger conventional two-pole, double-throw timing relay.

The new solid-state device, identified as the TD-181, utilizes zener regulation for guaranteed accuracy under presence of input voltage fluctuation and switching transients, and offers protection against damages from input polarity reversal.

The new crystal can, identified as the M200, occupies less than ⅓ cu. in. and offers high resistance to shock and vibration.

Circle No. 225 on Subscriber Service Card

Dual Orifice Nozzle

A standard, low-cost, dual-orifice nozzle for gas turbine engines has been developed by Delavan Manufacturing Co.

Basic parts, installation dimensions and materials are standard. Reasonable departures from these standards are available to allow for special flow rates or spray angles. Except for one aluminum seal, all parts are manufactured from corrosion-resistant stainless steel.

Circle No. 226 on Subscriber Service Card

Reluctance Stepper Motors

Two reluctance stepper motors representing a definite advance over the permanent magnet-type motors are being produced by Instrument Division of American Electronics, Inc. These stepper motors allow stepping in small increments of 15 to 7.5 degrees at the rate of 200 to 550 steps per second.

The two motors work in conjunction with a logic circuit which controls the rate, sequence and direction of the stepping action. They may be driven by electromechanical or electronic logic.

Circle No. 227 on Subscriber Service Card

Waveguide Switch

A compact single-pole, double-throw waveguide switch for use in RG-51/U waveguide systems (7.05-10.0 kMc/s) is available from Microwave Associates, Inc.

The MA-1064 switches are rated at 300 kW (kilowatts) peak power when operated unpressurized, and at 500 kW peak power when pressurized to 2 atmospheres. Units have been tested to over 400 kW peak power, unpressurized.

A low insertion loss of 0.15 db and a maximum VSWR of 1.10 over the entire waveguide band are important features of these switches.

Isolation in excess of 35 db is achieved by optimum design of internal chokes and by precision machining.

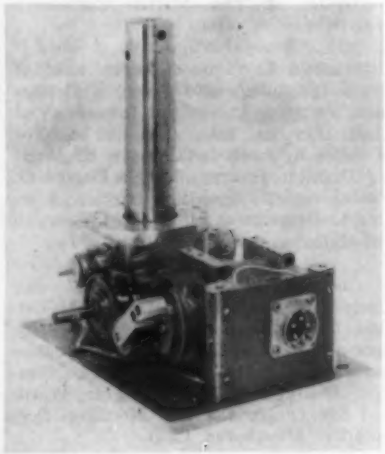
Circle No. 228 on Subscriber Service Card

Electric Servo Actuator

An 8-millisecond-response electric servo actuator for control of flight surfaces of missiles is available from American Electronics, Inc.

Utilizing a constant-speed miniaturized motor as its source of motion, and a clutch which gives left or right action, each flight control surface is directly connected to its own actuator.

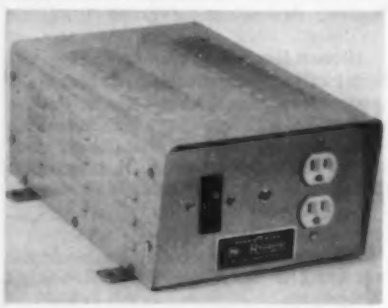
Weight savings of as much as 50% over hydraulic systems for the actuation of control surfaces are claimed in addition to the total elimination of piping, valves, filters, kinkages, accumulators and other plumbing accessories.



Circle No. 229 on Subscriber Service Card

DC-AC Inverter

Power Instruments Corp. is marketing a transistorized DC/AC Inverter Model PI 1341. This inverter converts



12V d-c to 115 a-c, 60 cps and will handle peak loads up to 1300 watts and continuous loads to 500 watts.

The device is designed to power a-c motors with high peak starting current surges and low starting power factors. Efficiency is 80% at full load.

Circle No. 230 on Subscriber Service Card

Light Cryogenic Pump

The Cosmodyne Corp. is manufacturing a single-cylinder, high-pressure, cryogenic pump, designed for low and medium flow ranges.

This unit, available from production, delivers liquefied gases, such as oxygen, nitrogen and hydrogen, at pressures up to 10,000 psi and flows up to 4.65 gpm (26,000 scfh of N_2).

The pump, although compact and weighing only 42 lbs., is designed for commercial and industrial applications, and features low maintenance operation.

The pump is designed with three separate thermal sections—cryogenic, intermediate and ambient temperatures—separating the cryogenic pumping end from the lubricated drive end.

Circle No. 231 on Subscriber Service Card

new literature

PIEZOELECTRIC DEVICES—A 16-page illustrated booklet on the application of piezoelectric devices is available from Clevite Electronic Components. Designed to show the principal existing and potential uses of piezoelectricity, the booklet outlines and compares the performance characteristics of all major piezoelectric substances. Text and tables cover piezoelectricity as applied to convert mechanical energy to electrical energy and the reverse. Electromechanical properties and useful service temperature ranges of piezoelectric elements are included.

Circle No. 200 on Subscriber Service Card

CLEANING CHEMICALS—A 14-page booklet describing ultrasonic cleaning chemicals has been issued by the ultrasonic power division of Branson Instruments, Inc. Practically a handbook, it gives extensive information on physical properties of most commonly used cleaning chemicals, as well as suggested applications, working temperatures, and procedures.

Circle No. 201 on Subscriber Service Card

MICROWAVE FREQUENCY—A reference table and band code letters and corresponding microwave frequencies is available from the Applied Dynamics Division of the Atlee Corp. Band codes are cross referenced with identifying sub letters, frequency band limits in kilomegacycles/seconds, and equivalent wavelengths in centimeters.

Circle No. 202 on Subscriber Service Card

The Lincoln Laboratory, Massachusetts Institute of Technology, announces a major expansion in its program. We urgently request the participation of senior members of the scientific community in our programs in:

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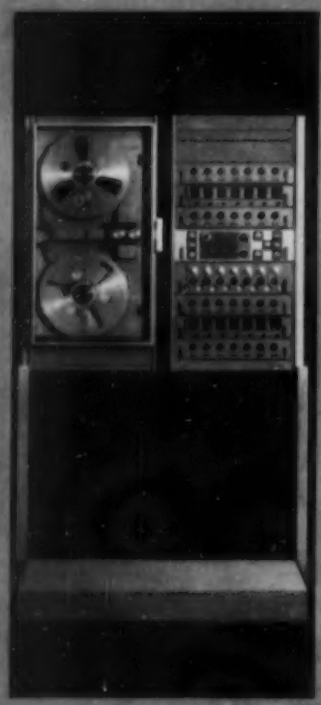

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contracts

NASA

$566,370—Carl N. Swenson Co., Inc., San Jose, Calif., for office and test chamber building for the mass transfer cooling and aerodynamics facility, Ames Research Center.

$86,500—Space Technology Laboratories, Inc., Los Angeles, for investigation of ion beam diagnostics.

$50,400—Ampex Corp., Atlanta, for transistorized magnetic instrument recording center.

NAVY

$9,500,000—Interstate Electronics Corp., Anaheim, Calif., letter of intent for design, manufacture and test of instrumentation systems for SSBN-616 *Polaris* submarines.

$8,500,000—Sperry Marine Division of Sperry Rand Corp. for management, design, manufacture, and installation of navigation equipment on newest *Polaris* submarines. (Two contracts.)

$5,000,000—Sylvania Electric Products, Inc., Waltham, Mass., for communication systems for *Polaris* submarines.

$2,000,000—ITT Federal Laboratories, Nutley, N.J., for marine communication and navigation equipment.

ARMY

$17,260,000—Systems Division of Bendix Corp., Ann Arbor, Mich., for development of communications system for Project *Advent*.

$4,936,812—Thiokol Chemical Corp., Marshall, Tex., for final assembly and loading of missile motors at Longhorn Ordnance Works.

$2,650,720—Capehart Corp., Richmond Hill, N.Y., for R-390(a) radio receivers.

$1,008,889—Dallas Building, Inc., Dallas, for nuclear warfare laboratory at Kirtland AFB, N.M.

$930,822—Acme Missiles & Construction Corp., Rockville Centre, N.Y., for construction of FPS-24 and FPS-26 radar tower facilities at Missile Master, Pittsburgh Defense Area, Oakdale, Pa.

$815,866—Radioplane Division of Northrop Corp., Van Nuys, Calif., for flight services for target missiles.

$500,000—Space Technology Laboratories, Inc., Los Angeles, for systems engineering and technical services on Project *Advent*.

$430,624—Aeronutronic Division of Ford Motor Co., Newport Beach, Calif., for *Nike-Zeus* missile system vulnerability study and technical reports.

$405,346—Belock Instrument Corp., College Point, N.Y., for industrial engineering services in connection with the *Hawk* missile training device 3-G-36.

$378,005—General Electric Co., Philadelphia, for additional services in connection with design, development and fabrication of the *XM-77* adaptation kit.

$290,000—Ryan Electronics, for spares for AN/APN-129(V) navigation sets.

$136,401—Raytheon Co., Waltham, Mass., for Doppler video transmitter for *Hawk* missile system.

$126,300—Keco Industries, Inc., Cincinnati, for unit conditioners for *Titan II* missile launch facilities.

$122,866—Herbert E. Ellis, Berkeley, Calif., for *Nike-Hercules* conversion, special AAA Site T-86 C&L, Solano Co., Calif.

$97,951—Haven Cooling Towers, Division of Haven Structural Steel Co., Kansas City, Mo., for cooling towers for *Titan II* missile launch facilities.

$95,000—Rixon Electronics, Inc., Silver Spring, Md., for custom-designed Sebit-24, data mode equipment.

$89,434—Associated Aero Science Lab, Hawthorne, Calif., for civilian technical assistance for *Jupiter*.

$65,338—Quinco Electric Co., Inc., Orlando, Fla., for instrumentation sites for the *Saturn* rocket complex, Cape Canaveral.

AIR FORCE

$5,000,000—Idaho Maryland Industries, Inc. and **Allied Engineering Co.,** Los Angeles, from **George A. Fuller Co.** and **Del A. Webb Construction Co.,** for miscellaneous *Minuteman* site hardware, Great Falls, Mont.

$3,400,000—Ryan Aeronautical Co., San Diego, for *Q-2C* aerial target drones, spare parts and special support equipment.

$1,800,000—Ryan Aeronautical Co.'s Aerospace Division, San Diego, letter contract for *Q-2C Firebees*.

$1,500,000—Infrared Industries, Inc., Riverside, Calif., from **Lockheed's Missiles and Space Division,** for advanced development and production engineering of infrared detectors for the *Midas* system.

$1,470,509—Kaminer Construction Corp., Chamblee, Ga., for fuel storage facility and modification of *Titan II* launchers, Cape Canaveral.

$500,000—Aerojet-General's Nuclear Propulsion Division, Azusa, Calif., for nuclear rocket engine research.

$497,050—General Dynamics/Electronics, Rochester, N.Y., for engineering, furnishing and installation of ultrahigh-frequency and single-sideband radio communications equipment for command and control functions of missile programs.

$260,000—Texas Instruments, Inc., Dallas, for major components of radar reconnaissance system AN/APQ-86.

$230,000—North American Aviation, Los Angeles, for development of rocket catapult.

$200,068—Electronics Division of Curtiss-Wright Corp., E. Paterson, N.J., for spare parts and related data for AN/GPN-T2B radar trainers.

$200,000—Hycon Manufacturing Co., Monrovia, Calif., for design and installation of high-altitude research cameras in *X-15* aircraft.

$150,000—Intercontinental Electronics Corp., Westbury, L.I., N.Y., for design and construction of improved electronic scan converter system.

$100,000—Hydro-Aire Co., Burbank, Calif., for research and development on production of a slurry transfer system.

$89,000—Radio Corp. of America, for use of the Moorestown, N.J., test facility for detection and tracking of satellites.

$71,587—American Optical Co., Southbridge, Mass., for a study of optical fiber techniques for data-processing equipment.

Precision Power Division of American Electronics, Inc., Fullerton, Calif., from **The Martin Co.,** Denver, for motor-generator sets for *Titan II* ground support. Amount not disclosed.

—when and where—

APRIL

Seventh Military Operations Research Symposium, ONR, at Boeing Airplane Co., Seattle, April 17-19.

Seventh National Instrument Society of America, Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, April 17-19.

Symposium on Chemical Reactions in the Lower and Upper Atmosphere, Stanford Research Institute, Mark Hopkins Hotel, San Francisco, April 18-20.

Bureau of Naval Weapons Missiles and Rockets Symposium, U.S. Naval Ammunition Depot, Concord, Calif., April 18-21.

American Geophysical Union and American Meteorological Society, Annual Meeting, National Academy of Sciences, Washington, D.C., April 18-21.

13th Annual Southwestern Institute of Radio Engineers, Conference and Electronics Show (SWIRECO), Memorial Auditorium, Dallas, April 19-21.

American Society of Mechanical Engineers, Metals Engineering Conference, sponsored with American Welding Society, Pennsylvania Sheraton Hotel, Pittsburgh, April 23-26.

Symposium on Structural Dynamics of High Speed Flight (confidential), Aerospace Industries Association and Office of Naval Research, AIA Auditorium, Los Angeles, April 24-26.

Aerospace Medical Association, Thirty-second annual meeting, Chicago, April 24-27.

American Rocket Society, Propellants, Combustion and Liquid Rockets Conference, Palm Beach Biltmore, Palm Beach, Fla., April 26-28.

High Temperature Materials Conference, AIME, Cleveland Section, Pick-Carter Hotel, Cleveland, April 26-27.

18th Annual Western Section Conference of The Society of the Plastics Industry, Hotel del Coronado, Coronado, Calif., April 26-28.

Seventh Region of the Institute of Radio Engineers, 1961 Conference, Hotel Westward Ho, Phoenix, April 26-28.

British Interplanetary Society, Symposium on Liquid Hydrogen as a Rocket Propellant, Royal Aeronautical Society, London, April 28.

MAY

Instrument Society of America, Seventh Annual Aerospace Instrumentation Symposium, Hotel Adolphus, Dallas, April 30-May 4.

Electric Components Conference, Institute of Radio Engineers, Electronic Industries Association, Western Electronic Manufacturers Association, American Institute of Electrical Engineers, Jack Tar Hotel, San Francisco, May 2-4.

ARS/ORNL Nuclear Applications in Space Conference, Oak Ridge National Laboratory, Gatlinburg, Tenn., May 3-5.

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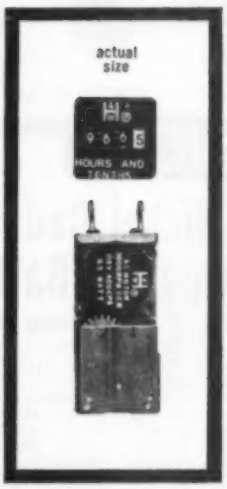

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ABC'S OF RADAR, Alan Andrews. Catalog No. ABR-1. Howard W. Sams & Co., Indianapolis 6, Ind. 112 pp., $1.95.

The book explains the fundamentals of radar in simple and understandable terms. It is designed to provide basic information on transmitter-receiver theory and operation to users of radar and operating and maintenance technicians. Representative radar systems are covered.

Chapters include: How Radar Works; Radar Systems; Microwaves; Microwave Oscillators; Timers and Modulators; Antenna Systems; Radar Receivers; Indicators.

ANALOG SIMULATION OF A PILOT-CONTROLLED RENDEZVOUS, Roy F. Brissenden, Bert B. Burton, Edwin C. Foudriat, and James B. Whitten. Order NASA Technical Note D-747 from National Aeronautics and Space Administration, Washington 25, D.C. 51 pp.

A simulator investigation has been made of the controls and instruments required for the rendezvous of a space ferry with an orbiting space station in the presence of various initial conditions and with ranges up to 50 miles.

A human pilot controlled a fixed-base simulator in six degrees of freedom. A single rocket and reaction-attitude controls were assumed.

A THERMODYNAMIC ANALYSIS OF THRUST AUGMENTATION FOR NUCLEAR ROCKETS, Hugh M. Henneberry, Lester C. Corrington, and Roger D. Becker. Order NASA Technical Note D-581 from National Aeronautics and Space Administration, Washington 25, D.C. 30 pp.

Thrust augmentation of the nuclear rocket system was obtained by the addition of chemical power. A liquid oxidant, oxygen or fluorine, was added to burn with the heated hydrogen propellant issuing from the reactor.

The specific impulse of the nuclear rocket afterburner was optimized by the addition of liquid hydrogen along with the oxidant. Data are presented for hydrogen reactor exit temperature from 3500° to 6500°R.

Comparison with other chemical thrust augmentation systems described herein indicated that the optimum afterburner is the most efficient method of chemical thrust augmentation for nuclear rockets.

AN INSTRUMENT TO MEASURE THE SOLAR CONSTANT FROM A SATELLITE, Rudolf A. Hanel. Order NASA Technical Note D-674 from National Aeronautics and Space Administration, Washington 25, D.C.

Satellites now provide the unique opportunity of measuring the solar constant directly, without interference from the atmosphere. The equilibrium temperature of an ideal black body mounted on, but thermally isolated from, a sun-oriented satellite, is governed by Stefan-Boltzmann's law.

A small hole in a spherical shell closely approaches such an ideal black body. A thermostat adjusts the temperature of the sensor housing close to the expected temperature of about 122°C, and thereby virtually improves the isolation further. A metal bolometer in a bridge circuit senses the temperature of the black body electrically.

STUDY OF SYSTEMS USING INERTIA WHEELS FOR PRECISE ATTITUDE CONTROL OF A SATELLITE, John S. White and Q. Marion Hansen. Order NASA Technical Note D-691 from National Aeronautics and Space Administration, Washington 25, D.C.

Various possible inertia wheel systems are examined for suitability for precise satellite attitude control; three of these systems, which appear more promising than the others, are analyzed in detail—using the Orbiting Astronomical Observatory as an example.

Theoretical and experimental investigations show that the system which uses an error-rate network to provide damping is superior to the other two systems. Experimental data taken under laboratory conditions with relatively large extraneous disturbances show that a dynamic tracking error of less than ± 0.5 sec. of arc was obtained.

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editorial . . .

Yield Not to Political Temptation

TOURING the missile/space industry in California these days is a lot like studying a can of worms. There's an awful lot of wiggling but not very much agreement on where everyone is going.

The president of one electronics firm will tell you business is good, costs are well in hand and profit margins are favorable. Another says things couldn't be worse. It depends a lot on whom you ask.

But one major question is voiced by almost every company executive you talk to in California. It is the same for both large and small firms. The question is this: Is the Kennedy Administration going to exact revenge on Richard M. Nixon's home state by diverting defense contracts elsewhere?

Politically, it would not be surprising. Nationally, it would be foolish, uneconomic and potentially dangerous. Let us hope the Kennedy Administration can rise above the natural temptation.

On this page last week, we argued the need for award of contracts on merit—not on the basis of depressed economic areas. The same reasoning applies in this case. Contracts must be awarded on merit—not geography.

Largely due to a favorable climate and accessibility of desert and sea test areas, California became the center of the U.S. aircraft industry before and during World War II. A large industrial labor pool was built up around that industry.

In the postwar period, a booming electronics industry dug its roots deep into both northern and southern California. Conditions for light industry were favorable and the sunshine looked great in the recruiting ads.

When the missile/space industry was born, many of the skills and techniques required were to be found in the two older industries, aircraft and electronics. It was natural that as the new industry evolved, it should be heavily concentrated in the same area.

Once again, climate and terrain played an important role. The Air Force found a hilly site for a rocket test base only a few miles across the dry lake from its Edwards Air Force Base Flight Test Center. Desert isolation made it easier to protect flights of the *X-10* and other early missiles from a security standpoint.

Aerojet-General found the non-arable land for its big rocket test site in the rocky gold fields near Sacramento. The Santa Susana mountains enabled Rocketdyne to carry out test firings on the very edge of Los Angeles. Lockheed bought thousands of acres on the northern California coast near Santa Cruz for a test base; United Technology last week dedicated its new test and development center on a 3200-acre site in the mountains near Morgan Hill, only 70 miles south of San Francisco.

In each case, these bases are within easy reach of the cities and industrial complexes needed to support them. Major universities are at hand to provide scientific backup.

All of these factors have combined to make California one of the most important centers in the missile/space industry. In spite of this, California dominates the missile/space industry far less than it did the aircraft industry.

New skills, new techniques were needed in the missile/space industry and many of them were to be found elsewhere. Top names in our industry today include many which were not active in airframe manufacture: General Electric, Western Electric, Westinghouse, RCA, IT&T, Raytheon, Bendix and others. The missile/space industry is spread far more evenly from a geographic standpoint than the aircraft industry was. Eastern firms play a much larger role.

Congressional representatives of other states, particularly New York, have been quick to sense California's political vulnerability. Its position as Nixon's home state, and as one which was in the Republican column in the presidential election, makes it an easy target. The overt attack is on other grounds, but this is the basis for it.

NEW YORK ARGUES against an over-concentration of defense contracts in California. Yet of the top ten firms in net value of military prime contracts in Fiscal 1960, only three are based in California; four are based in New York.

Of the top 25 firms on the list, only seven are in California.

This editorial is not in any way an argument for award of contracts in California, simply because it is California. A Western location as such is no more recommendation than an Eastern location. Merit must be the yardstick.

But one of the uncomfortable facts of life for the Californians is that any open and organized effort to fight the situation may only make it worse. How to fight a battle on political grounds which have not been acknowledged is a ticklish problem. Unscrupulous exploitation of the situation could do real harm to the nation's missile/space capabilities.

We urge the administration to put national interest above political interest. Geographic location must not for any reason be a determining factor in contract awards.

William J. Coughlin

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